

# ONE HEALTH TRAINING HANDBOOK

(Prepared for Officials)



**Health and Family Welfare Department**  
**Government of Kerala**

**KERALA.HEALTH**

**TRAINING HANDBOOK**  
**(Prepared for Officials)**

**Department of Health and Family Welfare**

**Government of Kerala**

## **Foreword**

The public healthcare system in Kerala functions with the objective of making quality healthcare from the primary to the tertiary level available to the entire population. Considering the contemporary situation where infectious diseases cause severe impacts on society, the State Government, with the support of the World Bank, has formulated comprehensive public health programs anchored in a 'One Health' approach. The State Government expects that implementing the One Health approach will help build effective systems to prevent and control outbreaks of infectious diseases, making Kerala a model for the entire country.

Kerala is the first state in India to launch a One Health program. Kerala achieved this milestone under the leadership of the Minister for Health and Family Welfare, Smt. Veena George. The One Health program, included as one of the key components of the Aardram Mission under the Nava Kerala Action Plan 2, was inaugurated by the Honourable Chief Minister, Shri Pinarayi Vijayan, on May 17, 2022. A unique approach has been adopted for implementing the One Health program in the state. Designed after consultations and planning with various departments, this program is being implemented in cooperation with the Local Self-Government Department. The strong local self-government system in Kerala will play a crucial role in the efficient implementation of the One Health program. Recognizing the imperative need to strengthen existing human resources, human resource empowerment (capacity building) has been included as a vital component of the One Health program. Along with this, necessary support and follow-up assistance will be provided to districts and local governments to ensure the efficient execution of the program.

This handbook has been prepared by compiling and coordinating information provided by experts from various departments in collaboration with the Centre for One Health - Kerala (COH-K) and the State Health Systems Resource Centre - Kerala (SHSRC-K). Except for the chapters covering the structure and organizational setup of the One Health program in Kerala, the remaining sections are the result of the joint efforts of various departments in the state. This handbook will be beneficial to the officials from various departments participating in the One Health training, as well as to the facilitators overseeing the training. Following the first phase of training, this handbook will be reviewed based on post-training feedback and experiences and will undergo necessary modifications.

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## Introduction

Kerala, which has made great strides in the social and economic sectors, is far ahead of other Indian states in the field of health as well. The hallmark of the renowned 'Kerala Health Model' is achieving health indicators like those of developed countries with a low capital investment. These achievements in the health sector are the result of the purposeful efforts of the democratic governments that came into power after the formation of the State. However, today, we must prepare ourselves to face various challenges that threaten human health worldwide.

Factors such as population growth, increasing human-wildlife interactions, and variations in the environment and climate are all emerging as challenges to human health in this era. If we are to achieve complete physical, mental, and social well-being or health, the health of living beings and nature must also be protected. The concept of "One Health" emerges from this realization.

**"One Health" is an approach that recognizes that the health of humans, birds and animals, plants, and nature, including their ecosystems, are interconnected and interdependent. By continuously monitoring the health of humans, living beings, and nature, this approach aims to take the necessary interventions to prevent the spread of various infectious diseases affecting humans and other living beings, detect emerging threats early, and control them.**

High population density, international travel due to migration, an increase in the elderly population, extensive forest areas, human-animal contact, and unscientific waste management are major factors increasing the risk of infectious diseases in the State. Keeping these circumstances in mind, it was decided to implement the One Health program to improve the health standards of the State. A One Health approach will be highly beneficial in controlling various infectious diseases continuously occurring in Kerala, such as zoonotic diseases (Nipah, Monkeypox, Scrub Typhus, etc.), mosquito/vector-borne diseases (Dengue, Malaria, Kala-azar, etc.), airborne diseases (Influenza including H1N1, COVID, TB, etc.), and waterborne diseases (Typhoid, Cholera, etc.).

The One Health program is being implemented under the Rebuild Kerala Initiative as part of the Nava Kerala Action Plan-2. The objective of the program is to bring together all related departments and strengthen existing systems to detect zoonotic diseases as early as possible and to prevent the spread of such diseases in a time-bound manner. The duration of this program, which started in 2021, is 5 years. In the first phase, the program is being implemented in the Pamba River Basin districts, namely Kottayam, Idukki, Alappuzha, and Pathanamthitta. In the next phase, it will be expanded to the remaining 10 districts. Annual targets have been set to achieve the objectives of the program. Currently, the 3rd-year activities are underway. The details of the annual targets are given below:

| <b>Year</b>                              | <b>Target</b>                                                                                                                                                                                                             |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Year 1</b><br>(July 2021 – June 2022) | Provide training under the leadership of the Department of Health and Family Welfare for the coordination of the One Health program at the district level in the Pamba Basin districts.                                   |
| <b>Year 2</b><br>(July 2022 – June 2023) | Train and deploy 250,000 volunteers under the leadership of the Department of Health and Family Welfare to strengthen community-based disease surveillance in the Pamba Basin districts.                                  |
| <b>Year 3</b><br>(July 2023 – June 2024) | Conduct routine infectious disease surveillance in the Pamba Basin districts through the trained volunteers, by collaborating with other departments under the leadership of the Department of Health and Family Welfare. |
| <b>Year 4</b><br>(July 2024 – June 2025) | Implement community-based disease surveillance across 150 local self-government areas in the Pamba Basin districts.                                                                                                       |
| <b>Year 5</b><br>(July 2025 – June 2026) | Effectively control infectious and zoonotic diseases identified through surveillance in the Pamba Basin districts.                                                                                                        |

The One Health program is being implemented in the state by including it under the "Multi-sector Resilience Programme for Results Operation", which aims to increase Kerala's resilience against sudden illnesses, infectious diseases, natural disasters, and climate change. The program is being implemented with financial assistance on a co-financing basis from the World Bank (IBRD) and the Asian Infrastructure Investment Bank (AIIB). Initially, the program emphasizes the control of zoonotic diseases followed by other infectious diseases. Subsequently, the objective is to intervene in all sectors of health, including non-communicable diseases and mental health, through the One Health approach.

The Director of the Health Department is responsible for the coordination of the program. The program is being implemented by the Center for One Health - Kerala under the Directorate of Health Services. To enable the coordination of various departments, One Health Committees have been formed at the state, district, and LSG levels involving the relevant departments.

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Other major components of the One Health program being implemented in the state include: creating public awareness about various aspects of the program including Antimicrobial Resistance (AMR); ensuring public participation in the execution of the program; communication exchange to facilitate coordination and cooperation among various departments; strengthening surveillance to detect illnesses in humans and other living beings as part of preventing infectious diseases; strengthening hospital laboratories; and capacity building for data analysis and decision-making. Information technology (IT) based systems will be utilized to effectively carry out tasks from disease surveillance to intervention. This handbook has been prepared for the training of officials from related departments as part of the One Health program. Across its chapters, it explains the concept and importance of One Health; matters that require the attention and intervention of various departments; the organizational setup of the One Health program in Kerala; existing and required changes in disease surveillance, diagnosis, and intervention systems across various departments; community-based disease surveillance; the roles and responsibilities of officials from various departments in the One Health program; and the coordination of different departments and integrated disease prevention activities at the state, district, and local self-government levels.

**Kerala is the first state in India to implement a One Health program. Just like in any other health program, it is expected that this training handbook will help ensure the participation of officials from related departments in implementing and making the One Health program a success.**

## Contents

| <b>Sl. No.</b> | <b>Chapter</b>                                                                                                                                   | <b>Page No.</b> |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 1              | One Health – Concept and Importance                                                                                                              | 13              |
| 2              | One Health – Topics Requiring Attention and Intervention of Various Departments                                                                  | 21              |
| 3              | One Health – Kerala and Organizational Setup                                                                                                     | 193             |
| 4              | One Health: Disease Surveillance, Diagnosis, and Intervention—Current Systems, Required Changes, and Community-Based Disease Surveillance Models | 203             |
| 5              | One Health Program – Duties and Responsibilities of Officials from Various Departments                                                           | 307             |
| 6              | Coordination of Various Departments and Integrated Disease Prevention Activities at State, District, and Local Self-Government Levels            | 323             |
| 7              | Summary                                                                                                                                          | 325             |
| 8              | Appendix 1 – Prepared By                                                                                                                         | 327             |
| 9              | Appendix 2 – International Days Related to One Health                                                                                            | 333             |



## Abbreviations

| <b>Acronym</b> | <b>Full Form / Translation</b>                        |
|----------------|-------------------------------------------------------|
| <b>AIIB</b>    | Asian Infrastructure & Investment Bank                |
| <b>AMR</b>     | Antimicrobial Resistance                              |
| <b>CBS</b>     | Community Based Surveillance                          |
| <b>CHC</b>     | Community Health Centre                               |
| <b>COH-K</b>   | Centre for One Health- Kerala                         |
| <b>DHS</b>     | Directorate of Health Services                        |
| <b>DPSU</b>    | District Program Support Unit                         |
| <b>IBRD</b>    | International Bank for Reconstruction and Development |
| <b>KARSAP</b>  | Kerala Antimicrobial Resistance Strategic Action Plan |
| <b>KILA</b>    | Kerala Institute of Local Administration              |
| <b>LSG</b>     | Local Self Government                                 |
| <b>NKKP</b>    | Nava Kerala Karma Padhathi                            |
| <b>NGO</b>     | Non-Governmental Organisation                         |
| <b>PHC</b>     | Primary Health Centre                                 |
| <b>PRI</b>     | Panchayat Raj Institution                             |
| <b>SOP</b>     | Standard Operating Procedure                          |
| <b>SPMU</b>    | State Program Management Unit                         |



**CHAPTER 1**  
**ONE HEALTH – CONCEPT AND IMPORTANCE**



## **One Health Concept**

With the objective of achieving better milestones in the health sector, One Health is an approach that ensures multi-level cooperation among various scientific disciplines operating at local, state, national, and global levels by recognizing the interconnectedness between humans, birds, animals, plants, and their shared environment. The concept of 'One Health' is based on the interdependence of the health of humans, animals, other living beings, and the environment. Although One Health is not a new concept, the finding that the continuous interaction between humans, birds, and animals impacts human health will make this concept even more critical in the coming years. Protecting human health by harming other living beings holds no relevance for the future. Instead, future health programs must be planned and implemented based on a comprehensive perspective regarding the health of humans, birds, animals, and the environment they commonly share.

The impact of the COVID-19 pandemic, which originated in Wuhan, China, was profound. The realization that such pandemics are not going to end makes the concept of One Health even more relevant. Furthermore, the One Health approach serves as a solution to the rising risks in global health. By ensuring equal importance to the health of humans, birds and animals, and environmental health, we can shape a new, sustainable world. As a result of population growth, the distance between human settlements and wildlife habitats has decreased. Interactions between humans, domesticated animals, and wild animals have increased. Consequently, diseases have begun to transmit from birds and animals to humans and vice versa. Such diseases are called zoonotic diseases (animal-borne diseases).

Since prehistoric times, humans have been domesticating birds and animals. Recognizing the various uses of animals, humans began utilizing them for diverse activities such as agriculture, hunting, food, warfare, and crop protection. The ecosystem we live in today is created through continuous give-and-take interactions between its components. During this period, major changes have occurred in the environment. Significant transformations took place in the ecosystem because of deforestation and the unscientific use of agricultural and industrial technologies. This has increased the probability of diseases spreading from birds and animals to humans. Most of the infectious diseases observed over the past three decades are zoonotic diseases. As a result of increased transportation facilities, diseases crossed international borders. A global strategy like One Health is essential to confront such risks posed to humans and animals by zoonotic diseases. In the coming years, greater importance must be given to this strategy to resolve health problems that may commonly affect humans, birds, animals, and the environment including plants.

Although the concept of One Health has existed for a long time, it has not been recognized on a global level for very long. Hippocrates, the father of medicine, recorded the relationship between environment and health, and its importance, in his book "On Airs, Waters, and Places". The relationship between nature and health is also described in the contributions of the Ayurveda Acharya, Charaka. Since 1800, scientists had begun to recognize the similarities between the diseases of birds, animals, and humans.



The history of One Health begins with Rudolf Virchow, who was a prominent pathologist. His study on roundworms in pigs prompted him to think about the connection between human and veterinary medicine. He was the one who began using the term 'zoonosis' for diseases that are mutually transmitted between humans, birds, and animals. The slogan 'One World, One Health' first emerged during a global symposium organized by the Wildlife Conservation Society in 2004. Detailed discussions were held then by bringing together experts from various fields regarding diseases transmitted between humans, birds, and animals. In 2007, representatives from 111 countries and various international organizations met in New Delhi with the objective of recommending a One Health approach to prepare for pandemics.

In 1994, a specific disease affected 21 horses and two humans at a horse stable in Australia. The Hendra virus, which spreads from fruit bats to horses, was the cause of the disease. A team consisting of zoologists, veterinarians, microbiologists, and sociologists was tasked with finding the origin of the virus, and they succeeded in doing so. This opened the possibilities of the "One Health" concept to the world.

The environment shared by humans, birds, and animals faces numerous challenges. These challenges affect humans, animals, birds, and the environment alike. Air and water quality issues, pesticides, and heavy metals are altering the environment. Furthermore, deforestation, changes in wildlife habitats, unscientific land use, and climate change are causing the emergence and spread of several zoonotic diseases. Coordination between various sectors is essential for the success of the One Health concept.

### **One Health – Importance**

The health of humans, animals, and the environment is linked to the activities of various sectors. Therefore, working by coordinating different sectors will benefit the health sector. Such collaborative interventions will enable us to face threats caused by variations in health issues. Each health problem caused by various diseases, pollution, lack of sanitation, unsustainable food security, natural disasters, and atmospheric temperature variations is different from one another. Therefore, policies formulated with the participation of various sectors will be highly helpful. It is in this context that the One Health approach becomes important. If the problems in the following sectors can be identified and prevented, the path to One Health will be easier.

## **One Health and Food Security**

Currently, millions of people in the world are starving. Food security is facing various challenges today. This crisis can only be resolved by increasing food production and grain storage. The role of One Health is significant in handling these challenges. The One Health approach is necessary to promote scientific agricultural practices, ensure cooperation by bringing changes to existing methods, and improve the health and well-being of people, birds, animals, and the environment.

## **One Health and Agriculture**

Foodborne diseases can spread through fruits and vegetables. Many plant-based foods and products that we once considered safe are now found to be the cause of foodborne illnesses. Many of the dangerous microorganisms found in these unsafe food items are zoonotic. We need to work collectively to keep such deadly microbes out of the food system. To increase production, many farmers adopt unscientific methods. The excessive use of pesticides and fertilizers without proper research is an example of this. There is also a possibility of serious health problems arising due to this. Implementing farming practices based on the concept of One Health will help prevent such dangers to a certain extent.

## **Water and Sanitation**

Millions of children die and suffer from serious health problems due to waterborne diseases. Due to the lack of proper drainage systems and a shortage of facilities to remove wastewater, the level of water pollution is increasing significantly. The amount of drinking water available on Earth is very limited. As a result of people's reckless behavior, these freshwater sources are becoming polluted. Furthermore, because of other human activities, dangerous chemical substances and heavy metals are polluting freshwater sources. This is causing serious health problems in humans, birds, animals, and the environment. Considering the growing population, the availability of fresh drinking water will be one of the major challenges in the times to come.

## **Bioterrorism and One Health**

The intentional spread of disease-causing or deadly microorganisms is called bioterrorism. Such terrorist activities will destroy a country's economy and create instability. The possibility of terrorist attacks against humans, animals, and agricultural crops is a serious threat faced by all countries. Such terrorism can be defeated by ensuring international cooperation in the public health sector.

## **Global Trade-Commerce and One Health**

The availability of international transport facilities has further aided cross-border trade and commerce. This has also had reflections in the health sector. Even though advanced treatment and the availability of medicines have increased, pathogens continue to cross borders through humans, living organisms, agricultural products, and other materials. This aids in the rapid

spread of diseases. Cooperation between countries in trade and commercial sectors, along with international travel safety, is essential to resolve these issues.

### **Zoonotic Diseases (Zoonoses, Reverse Zoonoses, Vertebrate animal)**

Zoonotic diseases are those that transmit from humans to birds and animals, or from birds and animals to humans. Rabies, bird flu, Kyasanur Forest Disease (monkey fever), Hendra virus, and swine flu are examples. To tackle zoonotic diseases, we must implement effective surveillance, coordination, and disease eradication systems. Many insects we encounter in our daily lives are carriers of pathogens that cause deadly diseases. Animal health experts and human health experts working together, focusing on comprehensive healthcare, will help defeat this menace.

### **Antimicrobial Resistance (AMR)**

Antimicrobial resistance is one of the major challenges facing the health sector. The unnecessary use of medicines in animals and humans, improper usage of medications, and inadequacies in the disposal methods of leftover medicines exacerbate this problem. This can only be countered through continuous awareness and interventions.

### **Climate Change**

Long-term changes are occurring in atmospheric temperatures and climate components. If we examine climate change, we can say that the atmospheric temperature is rising. This will have a significant impact on Earth in the coming years. This influence will also be evident in the medical treatment sector. In addition to causing heatwaves, floods, and diseases affecting humans, birds, and animals, it can also pose a threat to food security.

### **Biodiversity and One Health**

Kerala is rich in diverse living organisms. Our survival is made smooth through this biodiversity. With the destruction of habitats, the level of contact between living organisms and humans has increased, leading to dangerous changes in the food chain. To escape from this hazardous situation, the conservation of biodiversity and ecosystems is indispensable.

### **Wildlife Conservation**

One Health is a comprehensive approach that identifies and addresses the health of wildlife and the challenges they face. We can provide a healthy life for wild animals by preserving their natural habitats. The One Health approach is based on the understanding that forests are not merely a collection of trees, but that they exert a significant influence on society.

### **One Health**

By focusing on One Health, it is possible to resolve anything related to humans, birds, animals, and the environment they live in. Rather than just facing disasters, focus should be given to measures aimed at avoiding disasters.



### Protection of Human Health

- Vaccination / Immunization
- Infectious disease prevention
- Personal hygiene
- Health awareness
- Food security
- Disease diagnosis
- Treatment
- Medicines

### Protection of Animal and Bird Health

- Vaccination / Immunization
- Good food / Nutrition
- Hygiene / Sanitation
- Waste management
- Food security
- Scientific use of medicines

### Environmental Health

- Preventing environmental pollution
- Waste disposal activities
- Prevention of natural disasters
- Preventing global warming

## **CHAPTER 2**

### **ONE HEALTH – TOPICS REQUIRING ATTENTION AND INTERVENTION OF VARIOUS DEPARTMENTS**

## **Health Department**

Health is not merely the well-being of an individual, but rather the general well-being of society. Modern-day pandemics like COVID-19 give us the message that health threats must be confronted through coordinated interventions involving humans, flora, fauna, and the environment they belong to. The protection of human health is linked to the ecosystem and its other connecting links. Almost all infectious diseases begin in animals and spread to humans. In the future, this situation could become more severe. When people and departments capable of protecting and nurturing the health of humans, animals, the environment, and their related components work together with mutual understanding, the health of humans, animals, and the environment can be improved to the maximum extent.

This chapter discusses the matters that need to be focused on and intervened in by the departments related to the One Health program, to address health issues based on the interdependence of humans, flora, fauna, and microorganisms.

### **Major Issues Where the Health Department Needs to Intervene**

1. Zoonotic diseases
2. Vector-borne diseases
3. Waterborne diseases and foodborne diseases
4. Airborne diseases
5. AMR (Antimicrobial Resistance)

#### **1. Zoonotic Diseases**

##### **(a) Rabies**

The rabies virus travels through the nervous system, affects the brain, and manifests symptoms. After initial symptoms such as fever, headache, anxiety, cough, and sore throat, 80% of patients exhibit aggressive behavior, epilepsy-like symptoms, fear of water (hydrophobia) and wind (aerophobia), increased salivation, insomnia, and rapid breathing. In 20% of patients, fatigue and paralysis manifest. This is followed by a comatose state and death.

| Rabies                                                                                                                          |                  |                   |                                       |                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Main Symptoms                                                                                                                   | Pathogen (Agent) | Incubation Period | Transmission                          | Prevention                                                                                                                  |
| Fever, fatigue, shivering, anxiety, fear, changes in voice, insomnia, fear of wind, water, and light (hydrophobia/photophobia). | Rabies virus     | 3-8 weeks         | Through animals infected with rabies. | Stray dog control. If bitten, wash the wound for 10 minutes. Preventive vaccinations, and preventive vaccinations for pets. |

### Measures to be taken to prevent the disease:

If bitten or scratched by a pet or a stray dog suspected of having rabies, immediately approach the nearest healthcare provider.

### (b) Anthrax

- **Cutaneous Anthrax (Anthrax on the skin):**

The bacteria enter the body through cuts or wounds on the skin. It causes itching on the body, which later turns into a painless sore with a black centre. Swollen lymph nodes and fever are the symptoms.

- **Gastrointestinal Anthrax:**

The cause is consuming undercooked meat from an infected animal. Symptoms include nausea, vomiting, abdominal pain, headache, loss of appetite, fever, bloody diarrhea, and swelling of the neck.

- **Inhalation (Pulmonary) Anthrax:**

Infection occurs because of inhaling anthrax spores. Symptoms include a sore throat, mild fever, fatigue, muscle aches, chest discomfort, shortness of breath, nausea, coughing up blood, and pain when swallowing.

### Measures to be taken to prevent the disease:

Vaccination of cattle, proper disposal of dead animals (deep burial using lime, cremation), do not open the carcass as exposure to oxygen helps the bacteria form spores. Quarantine the area until all animals susceptible to the disease are vaccinated and dead animals infected with the disease are properly disposed of. Cleaning and disinfecting the environment is just as important as controlling insects and rodents.

### **(c) Bird Flu (Avian Influenza)**

Symptoms can range from mild to severe. The illness typically begins with normal flu-like symptoms, including a runny nose and cough. Other symptoms include sore throat, high fever, headache, muscle pain, conjunctivitis (red eyes), physical discomfort, diarrhea, vomiting, and breathing difficulties.

#### **Measures to be taken to prevent the disease:**

Avoid contact with infected birds, humans, and their secretions. Do not touch dead birds or those suspected of being infected with bare hands. Use gloves and plastic carry bags to transfer the carcasses of dead birds into a waste bin. Avoid traveling to places where bird flu has been reported.

### **(d) Monkey Fever (Kyasanur Forest Disease)**

Initial symptoms, including severe muscle pain accompanied by vomiting, digestive problems, and bleeding, may appear 3–4 days after infection. While one group of patients recovers within one to two weeks without major complications, about 10% to 20% of patients progress to a second phase with complex symptoms by the third week. In this stage, symptoms such as fever, severe headache, mental disturbances, tremors, vision loss, and neurological problems may be observed.

#### **Measures to be taken to prevent the disease:**

Prevent insect bites by wearing clothes that cover the arms and legs, and by using appropriate insect repellents. Insecticides are effective in reducing the population of ticks and other insects. Those who venture into forested areas or other open spaces for recreation or occupation (e.g., hunters, shepherds, forest department staff, farmers) are at a higher risk.

### **Monkey Fever**

| <b>Main Symptoms</b>                                                                     | <b>Pathogen (Agent)</b> | <b>Incubation Period</b> | <b>Transmission</b>                                                                         |
|------------------------------------------------------------------------------------------|-------------------------|--------------------------|---------------------------------------------------------------------------------------------|
| High fever, pain in the front of the forehead, bleeding from the nose, throat, and gums. | Flavivirus              | Up to 3–8 days           | Transmitted through tick bites. Ticks are found on the bodies of monkeys and other rodents. |

### (e) Nipah

Once the Nipah virus enters the body, symptoms will begin to appear within 5 to 14 days. Fever, headache, and drowsiness are the initial symptoms. Following this, confusion and loss of consciousness may occur. Respiratory problems may also arise during the initial phase. Within 24 to 48 hours, the patient may go into a prolonged state of unconsciousness (coma). The possibility of the virus spreading is higher from Nipah patients who have breathing difficulties and those aged above 45 years.

#### Measures to be taken to prevent the disease

Avoid contact with bats and sick pigs during an outbreak. Avoid eating fruits bitten by bats.

| Nipah                                                                                                                                   |                  |                   |                                                      |                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Main Symptoms                                                                                                                           | Pathogen (Agent) | Incubation Period | Transmission                                         | Prevention                                                                                                                                                                                                             |
| Fever along with severe headache, vomiting, fatigue, exhaustion, loss of consciousness, visual disturbances, respiratory distress, etc. | Nipah virus      | 5–14 days         | Through the air and through contact with the patient | Individuals should wear gloves, boots, and masks. Sanitization/disinfection should be carried out if there is contact with the patient or the patient's excretions. Follow instructions given by hospital authorities. |

### (f) Leptospirosis (Rat Fever)

This is a disease that affects farmers, plantation workers, sanitation workers, slaughterhouse workers, veterinarians, animal husbandry workers, dairy farmers, and people working under employment guarantee schemes or working outdoors or with animals. People swimming, kayaking, or rafting in contaminated lakes and rivers are also prone to contracting this disease. Leptospirosis infection has also been reported in children living in cities. A person becomes infected between 2 days to 4 weeks after meeting a contaminated water source.

Usually, the disease starts suddenly with a fever and other symptoms. Leptospirosis can occur in two phases. Although the patient may recover for a short period after the first phase—which includes fever, chills, headache, muscle pain, vomiting, diarrhoea, jaundice, and redness of the

eyes—the illness is likely to return. For some infected individuals, it can even cause death due to damage to the kidneys and heart.

### Measures to be Taken to Prevent the Disease

Avoid stepping into or meeting water that may be contaminated with animal urine. Avoid contact with infected animals. Those who must enter contaminated water or mud as part of their work or for recreation—especially during the rainy season—must mandatory wear appropriate protective clothing or footwear.

**Rat Fever (Leptospirosis) Information Chart**

| Main Symptoms                                                                                                                                                                                                                                   | Agent (Pathogen)           | Incubation Period | Transmission                                                                                                                                                                                                                                                                                                                                                                                                                           | Prevention                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>* Severe fever, chills, and shivering.</li> <li>* Severe body pain.</li> <li>* Jaundice (yellowing of eyes/skin), redness in the eyes, and vomiting.</li> <li>* <b>Warning:</b><br/>The stage</li> </ul> | <i>Leptospira</i> bacteria | Two weeks         | <ul style="list-style-type: none"> <li>* Water or food contaminated with animal urine spreads the disease.</li> <li>* The bacteria enter the body through small skin blisters, open wounds/cuts, transparent mucous membranes (like the conjunctiva of the eyes), and nostrils.</li> <li>* <b>High-Risk Groups:</b> Laborers working in contaminated water (including employment guarantee scheme/MGNREGA workers) and farm</li> </ul> | <p>Effective treatment is available if detected early.</p> <p>Do not bathe or wash your hands and feet in contaminated water. Sanitation workers and farmers must wear boots (footwear) and take the preventive medicine, <b>Doxycycline.</b></p> |

| Main Symptoms                                                                                                                | Agent (Pathogen) | Incubation Period | Transmission | Prevention |
|------------------------------------------------------------------------------------------------------------------------------|------------------|-------------------|--------------|------------|
| starting from jaundice is highly dangerous. Patients often die because the infection severely affects the kidneys and liver. |                  |                   |              |            |

## 2. Vector-Borne Diseases (Vector-Borne Infections)

### • Dengue Fever

Dengue fever is a vector-borne disease transmitted to humans through the bite of infected mosquitoes belonging to the *Aedes aegypti* genus. Symptoms in an infected person include fever, headache, body ache, pain in muscles and joints, pain behind the eyes, and a sore throat. Dengue fever presents in three main forms: normal viral fever, hemorrhagic fever (fever accompanied by bleeding), and Shock Syndrome. If the blood platelet count drops drastically, causing severe internal bleeding, it can even lead to death.

### • Malaria

Malaria is an infectious disease spread by mosquitoes belonging to the *Anopheles* genus. This disease is caused by unicellular protozoan parasites belonging to the genus *Plasmodium* (Phylum: Protozoa). The primary symptoms include fever accompanied by shivering, chills, headache, body ache, fatigue, jaundice, vomiting, and cough. If the disease is not identified through symptoms, confirmed via blood test, and treated effectively, it can potentially lead to death.

Apart from Malaria and Dengue fever, other major vector-borne diseases commonly found in our region are detailed in the table below.

|                          |                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>      | <b>Malaria</b>                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Main Symptoms</b>     | <b>Intermittent fever accompanied by shivering, severe headache, nausea, and vomiting. Symptoms typically recur at intervals of 48 hours.</b>                                                                                                                                                                                                                                       |
| <b>Agent (Pathogen)</b>  | <p>4 types of unicellular organisms called <i>Plasmodium</i>:</p> <ul style="list-style-type: none"> <li>* <i>Plasmodium vivax</i></li> <li>* <i>Plasmodium falciparum</i></li> <li>* <i>Plasmodium malariae</i></li> <li>* <i>Plasmodium ovale</i></li> </ul>                                                                                                                      |
| <b>Incubation Period</b> | 9 to 14 days (can range from 9 to 40 days).                                                                                                                                                                                                                                                                                                                                         |
| <b>Transmission</b>      | The disease is transmitted from person to person through the bite of female <i>Anopheles</i> mosquitoes. Due to the influx of migrant laborers into Kerala from states where malaria is widespread, there has been an increase in reported cases recently.                                                                                                                          |
| <b>Prevention</b>        | Effective diagnosis and treatment are available completely free of charge through Primary Health Centers (PHCs). Keeping patients under mosquito nets prevents the further spread of the disease. Since <i>Anopheles</i> mosquitoes breed in overhead tanks, they must be securely covered with mosquito nets, and other mosquito control measures must be implemented effectively. |

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>      | <b>Dengue Fever</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Main Symptoms</b>     | <p><b>Dengue fever presents in three forms:</b></p> <ol style="list-style-type: none"> <li><b>1. Classic Dengue Fever:</b> Severe headache, pain behind the eyes, difficulty looking at bright light (photophobia), and redness in the eyes.</li> <li><b>2. Dengue Hemorrhagic Fever:</b> Bleeding from the nose and gums, vomiting blood, and tiny blood spots (petechiae) appearing on the forehead, hands, and feet.</li> <li><b>3. Dengue Shock Syndrome:</b> Low blood pressure, weak pulse rate, increased breathing rate, extreme fatigue, restlessness, excessive thirst, and cold, pale skin. Bleeding through the gums, nose, and skin. All of these are symptoms of severe dengue progression.</li> </ol> |
| <b>Agent (Pathogen)</b>  | Flaviviruses (DENV 1-4)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Incubation Period</b> | 5 to 8 days.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Transmission</b>      | <p>Within the first 5 days of the onset of the disease, while the patient still has a fever, if an <i>Aedes</i> genus (Tiger Mosquito) feeds on their blood, the mosquito becomes infected with the pathogen. Thereafter, the mosquito spreads the disease for the remainder of its lifespan.</p>                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Prevention</b>        | <p>Vaccine is not available.</p> <ol style="list-style-type: none"> <li>1. Destroy mosquito breeding sites.</li> <li>2. Use mosquito repellents and wear clothes that fully cover the body.</li> <li>3. Keep patients under mosquito nets to prevent further transmission.</li> </ol> <p>These are the primary preventive measures.</p>                                                                                                                                                                                                                                                                                                                                                                              |

|                          |                                                                                                                                                                                                                                                                                                                |
|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>      | <b>Chikungunya</b>                                                                                                                                                                                                                                                                                             |
| <b>Main Symptoms</b>     | Severe fever, joint pain, difficulty walking and sitting, bending forward due to extreme pain, and red rashes on the body.                                                                                                                                                                                     |
| <b>Agent (Pathogen)</b>  | Chikungunya virus                                                                                                                                                                                                                                                                                              |
| <b>Incubation Period</b> | 1 to 12 days.                                                                                                                                                                                                                                                                                                  |
| <b>Transmission</b>      | Transmitted through the bites of <i>Aedes</i> mosquitoes.                                                                                                                                                                                                                                                      |
| <b>Prevention</b>        | <p><b>Vaccine is not available.</b></p> <ol style="list-style-type: none"> <li>1. Destroy mosquito breeding sites.</li> <li>2. Use mosquito repellents and wear clothes that fully cover the body.</li> <li>3. Keep patients under mosquito nets.</li> </ol> <p>These are the primary preventive measures.</p> |

**Note in chart:** 2/3 of the world's filariasis patients are in India, China, and Indonesia.

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>      | <b>Filariasis</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Main Symptoms</b>     | Swelling of the Lymph Glands, filarial fever, headache, vomiting, chills, and shivering.                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Agent (Pathogen)</b>  | Three types of nematode worms: <i>Wuchereria bancrofti</i> , <i>Brugia malayi</i> , and <i>Brugia timori</i> .                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Incubation Period</b> | 8 to 16 months.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Transmission</b>      | <p>The disease is transmitted by carriers who harbor <i>microfilariae</i> (the young larvae of filarial worms) in their blood but do not exhibit external symptoms of the disease. Chronic filariasis patients themselves do not transmit the disease.</p> <p>Mosquitoes belonging to the <i>Culex</i>, <i>Anopheles</i>, <i>Mansonia</i>, and <i>Aedes</i> genera spread <i>Bancroftian filariasis</i>, while <i>Aedes</i> and <i>Mansonia</i> mosquitoes spread <i>Brugian filariasis</i>.</p> |

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b> | <b>Filariasis</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Prevention</b>   | <p>Transmission can be prevented by eliminating microfilaria carriers. For this purpose, the <b>MDA (Mass Drug Administration) Programme</b> is being implemented, where highly effective DEC (Diethylcarbamazine) and Albendazole tablets are distributed once a year to eliminate filariasis. Our country can only become filariasis-free if more than <b>80%</b> of the population consistently takes these tablets annually for 5 to 10 consecutive years.</p> |

|                          |                                                                                                                                                                                                |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>      | <b>Japanese Encephalitis</b>                                                                                                                                                                   |
| <b>Main Symptoms</b>     | Fever, headache, vomiting, epilepsy-like symptoms (seizures), loss of consciousness (coma), Cachexia (severe wasting of the body), and Hemiparesis (weakness on one side of the body).         |
| <b>Agent (Pathogen)</b>  | JE virus belonging to the <i>Flavivirus</i> genus.                                                                                                                                             |
| <b>Incubation Period</b> | 5 to 15 days.                                                                                                                                                                                  |
| <b>Transmission</b>      | The primary cycle of transmission occurs from pigs to pigs via mosquitoes. Mosquitoes that acquire the pathogen from infected pigs then transmit the disease to humans.                        |
| <b>Prevention</b>        | <p>The disease is typically spread by the <i>Culex</i> mosquito (<i>Culex tritaeniorhynchus</i>).</p> <p>Make mosquito control operations more effective. <b>Vaccination is available.</b></p> |

|                          |                                                                                                                                                                                                        |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>      | <b>Kala-azar / Visceral Leishmaniasis</b>                                                                                                                                                              |
| <b>Main Symptoms</b>     | Fever, darkening/blackening of the skin, nodules or lesions on the skin, weight loss, etc.                                                                                                             |
| <b>Agent (Pathogen)</b>  | A parasite called <i>Leishmania</i> .                                                                                                                                                                  |
| <b>Incubation Period</b> | 5 to 15 days. <i>[Note: While the text states 5 to 15 days, the standard medical incubation period for Kala-azar typically spans weeks to months].</i>                                                 |
| <b>Transmission</b>      | Transmitted when a sandfly bites an infected patient and subsequently bites another person.                                                                                                            |
| <b>Prevention</b>        | Destroy sandflies and eliminate their breeding environments. Ensure personal protection when meeting cattle sheds/pens. Spray insecticides, and plaster walls (to close cracks where sandflies breed). |

**Mosquito-Borne Diseases, Vector Mosquitoes, and Their Characteristics**

| <b>Disease</b>                           | <b>Pathogen (Agent)</b> | <b>Mosquito (Vector)</b> | <b>Characteristics / Breeding Habits</b>                                                                           |
|------------------------------------------|-------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>Malaria</b><br><br><i>(Malampani)</i> | <i>Plasmodium</i>       | <i>Anopheles</i>         | Lays eggs in clear, stagnant water. Overhead water tanks are a preferred breeding ground. Feeds on blood at night. |
| <b>Filariasis</b>                        | Filarial worms          | <i>Culex</i>             | Lays eggs in contaminated/polluted water. Feeds on blood at night.                                                 |

| Disease                                                     | Pathogen (Agent)                                                                            | Mosquito (Vector) | Characteristics / Breeding Habits                                                                                                                           |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ( <i>Manth</i> )                                            | ( <i>Wuchereria bancrofti</i> ,<br><br><i>Brugia malayi</i> ,<br><br><i>Brugia timori</i> ) | <i>Mansonia</i>   | Lays eggs in water bodies containing aquatic plants like water hyacinth ( <i>Eichhornia</i> ) and water lettuce ( <i>Pistia</i> ). Feeds on blood at night. |
| <b>Japanese Encephalitis</b><br><br>( <i>Japan Jwaram</i> ) | Flavivirus                                                                                  | <i>Culex</i>      | Lays eggs in contaminated/polluted water. Feeds on blood at night.                                                                                          |
|                                                             | (JE Virus)                                                                                  | <i>Mansonia</i>   | Lays eggs in water underneath the leaves of aquatic plants like water hyacinth and water lettuce. Feeds on blood at night.                                  |
| <b>Dengue Fever</b>                                         | Flavivirus<br><br>(Dengue Virus 1-4)                                                        | <i>Aedes</i>      | Lays eggs in relatively clean water stored in containers or collected in discarded, unused vessels. Primarily feeds on blood during the daytime.            |
| <b>Chikungunya</b>                                          | Alphavirus<br><br>(Chikungunya Virus)                                                       | <i>Aedes</i>      | Lays eggs in relatively clean water stored in containers or collected in discarded, unused vessels. Primarily feeds on blood during the daytime.            |
| <b>Non-disease transmitting mosquito</b>                    | <i>None</i>                                                                                 | <i>Armigeres</i>  | Lays eggs in highly contaminated wastewater found in septic tanks and cattle sheds. Feeds on blood during dusk (evening) and dawn (early morning).          |

## Mosquito Control Measures

Mosquito control is achieved by destroying mosquitoes at any single stage of their life cycle. Various methods can be adopted for control, such as locating and destroying breeding sites, destroying larvae (wigglers), and destroying fully grown adult mosquitoes.

### Know the Aedes Mosquito

1. This is a small mosquito found commonly across both urban and rural areas in our region.
2. *Aedes aegypti* and *Aedes albopictus* are the species that spread Dengue and Chikungunya.
3. In Kerala, *Aedes albopictus* mosquitoes are the most predominantly found species. Generally black in color with white stripes and dots on its body, this mosquito has a habit of relentlessly pursuing humans to feed on blood. Due to these features, they are commonly called **Tiger Mosquitoes**.
4. They breed by laying eggs in relatively clean water found inside or around the house in various types of containers, whether kept for specific purposes or left discarded.
5. Because pathogen-carrying mosquitoes bite and feed on the blood of multiple people before laying eggs just once, it causes the disease to spread very rapidly.
6. They primarily feed on blood during the **daytime**.
7. The eggs of the Aedes mosquito stick firmly to the inner sides of containers. Therefore, they can only be removed if the inner surfaces of the containers are scrubbed thoroughly while washing.
8. Their eggs have the ability to survive dry conditions for **more than six months**. Because of this, even in dried-out containers, the eggs do not perish and have the potential to hatch whenever water falls into them again.
9. Aedes mosquitoes are capable of passing the viruses down to their next generation through their eggs (**Transovarial Transmission**).
10. They only have the capacity to fly a distance of **100 meters to 400 meters**. However, they can travel long distances by hitching a ride inside vehicles.

### Bio-Environmental Control

During the periods when there is no active outbreak of the disease (**Inter-epidemic period**), simple, cost-effective, environmentally friendly, and effective mosquito control measures must be adopted. Examples include source reduction (destroying breeding sources) and biological control.

Chemical control methods should ideally be reserved and adopted only during periods when disease transmission is at its peak. Excessive use of chemical insecticides can cause direct harm to humans. Furthermore, chemical methods are expensive and can cause mosquitoes to develop resistance against the insecticides. Therefore, bio-environmental control measures are highly preferred.

## Source Reduction (Source Destruction)

- Properly dispose of or store items that serve as breeding grounds for Aedes mosquitoes—such as coconut shells, tires, cups, bottles, mortars, pots, tins, barrels, polythene, plastic covers, and sheets—in a manner that prevents water from accumulating inside them.
- Do not throw away waste carelessly; instead, segregate and process it directly at its source.
- Keep all water storage containers and tanks tightly closed to prevent mosquitoes from entering. If mosquito larvae (wigglers) are found, the water must be strained using a clean cloth before use.
- Do not pour fresh water directly into tanks or containers that still have leftover water. Completely drain and clean them before refilling with fresh water.
- Empty the water from storage containers **once a week**, scrub the inner walls thoroughly, dry them completely, and then refill them.
- Fill pits and hollows where water is likely to stagnate with soil, or drain the stagnant water away.
- Ensure water does not collect in unused tires by either drilling holes in them or filling them with soil.
- Do not allow water to pool on house terraces or sunshades.
- Inspect coolers, refrigerators (defrost trays), and the trays kept under flowerpots **once a week** to ensure no water is stagnating in them.
- Drain out stagnant water or fill with soil any hollow cavities in trees, as well as the leaf axils of plants like taro (*Chembu*), banana trees, and pineapples.
- Turn upside down the coconut shells or cups kept in rubber plantations for collecting latex during the rainy season.
- Burn or bury raw coconuts and cocoa pods that have been chewed and left open by rats or squirrels.
- Clear obstructions in drainage channels to ensure a free flow of water.
- Cover the vent pipes of septic tanks with a fine mesh net. Seal any gaps between concrete slabs by carrying out timely maintenance work.
- Since the eggs of Aedes mosquitoes can survive undamaged for a very long time in dried-out, non-biodegradable waste materials, completely remove all such dry sources (containers) even if they do not currently hold water.

## Biological Control

- Larvivorous fish (larvae-eating fish) such as **Manathukanni** (*Aplocheilus* / Toothcarp), **Guppy**, and **Gambusia** can be introduced into wells, ponds, tanks, fountains, and temporary water bodies to control mosquito larvae.
- Do **not** introduce fish into water bodies where bleaching powder has been added.
- Newly constructed or unused tanks can be modified and set up to rear Guppy fish. Fish distribution can be carried out based on local requirements.

- Mosquito larvae can also be destroyed by spraying specific types of bacterial formulations (e.g., *Bt* larvicides).

### Chemical Control Methods

- In abandoned, undrainable water bodies and stagnant drains where larvivorous fish are absent, larvicides such as **Temephos** or **Fenthion** can be sprayed using a spray pump to destroy mosquito larvae.
- Kerosene, burnt oil (waste engine oil), etc., can also be applied over stagnant water surfaces to act as a larvicide.
- Areas where vehicle tires are stacked—such as tire retreading centres, tube-repair shops, godowns, workshops, garages, and tire depots—must be closely monitored. If needed, Temephos or "**Baytex**" granules must be sprinkled inside tires left outdoors in specified quantities. Doing this approximately once every three months is sufficient. For water bodies holding less than 25 liters, roughly a pinch of granules is enough. For 50 liters of water, one teaspoon or 5 grams of granules should be used.
- In areas where mosquito-borne diseases have been reported, outdoor **FOGGING (smoke fumigation)** must be carried out in residential compounds and public spaces using insecticides like Malathion or Pyrethrum. Fogging machines are utilized for this purpose.
- It is the insecticide released along with the dense smoke powered by petrol and diesel from the fogging machine that kills the mosquitoes. The ideal times to conduct fogging are early morning and evening. For scientifically effective fogging, 3 machines are utilized concurrently.
- Inside houses, insecticides such as **Pyrethrum** or **Cyfluthrin** mixed with kerosene can be sprayed using a hand pump.

### Personal Protective Measures

- Apply repellent lotions or creams to exposed skin (such as Neem oil, etc.).
- Wear clothing that fully covers the body.
- Use insecticide-treated mosquito nets (ITNs).
- Install wire mesh/nets on windows, doors, and ventilators to prevent mosquitoes from entering the house.

### Mosquito Density Study

During house visits, inspect the inside, overhead areas, and surroundings of the house to see if conditions exist that allow *Aedes* mosquitoes to breed, and record the findings in the designated form. Based on the survey report, determine the *Aedes* density indices to identify areas prone to disease outbreaks and intensify source reduction activities there.

**ISS (Indoor Space Spray) Reference Table**

| Name of Insecticide      | Commercial Formulation | Ratio / Quantity | Equipment                   | Remarks |
|--------------------------|------------------------|------------------|-----------------------------|---------|
| <b>Pyrethrum Extract</b> | 2.0% Extract           | 1:19             | Pressure Spray Machine      | ISS     |
| <b>Cyfluthrin</b>        | 5% EC                  | 0.5 to 20 ml     | Do (Pressure Spray Machine) | ISS     |

### Personal Protective Measures

- Apply repellent lotions to exposed skin (such as Neem oil, etc.).
- Wear clothing that fully covers the body.
- Use insecticide-treated mosquito nets (ITNs).
- Install wire mesh/nets on windows, doors, and ventilators to prevent mosquitoes from entering.

### Surveillance Methodologies for Vector Spread

The following epidemiological indices are calculated to monitor and detect the spread of the mosquito population:

$$\text{Container Index (CI)} = \frac{\text{Number of positive containers found with larvae}}{\text{Total number of containers examined}} \times 100$$

$$\text{House Index (HI)} = \frac{\text{Number of houses found positive for larvae}}{\text{Total number of houses examined}} \times 100$$

**Risk Assessment (House Index):** If the House Index is **above 10%**, the probability of vector-borne disease transmission is considered very high.

$$\text{Breteau Index (BI)} = \frac{\text{Number of positive containers found with larvae}}{\text{Total number of houses examined}} \times 100$$

**Risk Assessment (Breteau Index):** > \* If the Breteau Index is **below 5**, the probability of disease transmission is very low.

- If the Breteau Index is **above 50**, the risk of an outbreak/transmission is exceptionally high.

### Sample Survey Form

1. House Number
2. Name of the Head of the Household
3. Number of containers and situations found in the house with stagnant water or potential for water stagnation.
4. Number of containers/waterlogged areas where mosquito larvae were detected.
5. Number of houses where mosquito larvae were detected.

### Waterborne and Foodborne Diseases

#### 1. Typhoid

Typhoid is a disease contracted through contaminated food and the use of contaminated water. It is a disease caused by the bacterium *Salmonella typhi*. It affects the small intestine and causes severe fever, abdominal pain, and other symptoms. It is also called Enteric Fever.

- Symptoms: A fever that fluctuates (decreases and increases) daily, headache, fatigue, muscle pain, sweating, dry cough, loss of appetite, abdominal pain, and diarrhea or constipation.
- Management & Prevention: Antibiotic treatment must be initiated if typhoid fever is detected. Typhoid fever can be prevented through vaccination.

#### 2. Hepatitis A

Hepatitis A is an infectious disease contracted through contaminated food and water. Symptoms usually appear 2 to 4 weeks after infection.

- Symptoms: Fever, vomiting, clay-colored/grey stool, fatigue, headache, nausea, jaundice (yellowing of eyes/skin), and dark-colored urine.
- Diagnosis: The severity of the disease can be assessed by testing the patient's blood for SGPT, SGOT, and Bilirubin levels.
- Management & Prevention: There is no specific medical cure for the disease itself. Rest, drinking plenty of fluids, and supportive care to stimulate liver function can be undertaken as per a doctor's advice. A vaccine for Hepatitis A is available.

### Other Waterborne Diseases

In addition to Typhoid and Jaundice (Hepatitis), other major waterborne diseases commonly found in our region are tabulated below:

|                             |                                                                                                                                                                                                                                                                                                                            |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Diarrhea</b>                                                                                                                                                                                                                                                                                                            |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                                                                                             |
| <b>Major Symptoms</b>       | Diarrhea lasting from 3 days up to 2 weeks, vomiting, and dehydration.                                                                                                                                                                                                                                                     |
| <b>Causative Agent</b>      | Virus, Bacteria, Protozoa                                                                                                                                                                                                                                                                                                  |
| <b>Incubation Period</b>    | From a few hours up to 2 days.                                                                                                                                                                                                                                                                                             |
| <b>Mode of Transmission</b> | Through food, water, and contact with an infected patient.                                                                                                                                                                                                                                                                 |
| <b>Prevention</b>           | <ul style="list-style-type: none"> <li>* Use only boiled and cooled water for drinking.</li> <li>* Use Oral Rehydration Therapy (ORS/fluid management).</li> <li>* Chlorinate drinking water sources once every two weeks.</li> <li>* Wash hands thoroughly with soap before eating and after using the toilet.</li> </ul> |

|                             |                                                                                                                                                                                                                                                                                                                            |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Cholera</b>                                                                                                                                                                                                                                                                                                             |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                                                                                             |
| <b>Major Symptoms</b>       | Continuous watery diarrhea resembling rice-water, and severe dehydration.                                                                                                                                                                                                                                                  |
| <b>Causative Agent</b>      | A bacterium named <i>Vibrio cholerae</i> .                                                                                                                                                                                                                                                                                 |
| <b>Incubation Period</b>    | From a few hours up to 5 days.                                                                                                                                                                                                                                                                                             |
| <b>Mode of Transmission</b> | Water, hands, and other objects contaminated by the feces, urine, or vomit of patients and disease carriers.                                                                                                                                                                                                               |
| <b>Prevention</b>           | <ul style="list-style-type: none"> <li>* Drink well-boiled and cooled water.</li> <li>* Wash hands thoroughly with soap before eating food and after using the toilet.</li> <li>* Disinfect vomit and feces using an appropriate disinfectant.</li> <li>* Conduct super-chlorination of drinking water sources.</li> </ul> |

|                             |                                                                                                                                                                                                                                                                                                                               |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Hepatitis-A</b>                                                                                                                                                                                                                                                                                                            |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                                                                                                |
| <b>Major Symptoms</b>       | Abdominal pain, loss of appetite, nausea, vomiting, diarrhea, and dark-colored urine.                                                                                                                                                                                                                                         |
| <b>Causative Agent</b>      | Hepatitis-A virus.                                                                                                                                                                                                                                                                                                            |
| <b>Incubation Period</b>    | From 15 to 50 days.                                                                                                                                                                                                                                                                                                           |
| <b>Mode of Transmission</b> | Transmission is highest starting from one week before the onset of symptoms and continuing for about a week after symptoms begin.                                                                                                                                                                                             |
| <b>Prevention</b>           | <ul style="list-style-type: none"> <li>* Use only well-boiled and cooled water.</li> <li>* Wash hands thoroughly with soap before eating food and after using the toilet.</li> <li>* Disinfect vomit and feces using an appropriate disinfectant.</li> <li>* Conduct super-chlorination of drinking water sources.</li> </ul> |

: (ടെട്രഫോയ്ഡ്)

|                             |                                                                                                                                                                              |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Typhoid</b>                                                                                                                                                               |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                               |
| <b>Major Symptoms</b>       | Sudden onset of fever, severe headache, and splenomegaly (enlargement of the spleen).                                                                                        |
| <b>Causative Agent</b>      | A Gram-negative bacterium named <i>Salmonella typhi</i> .                                                                                                                    |
| <b>Incubation Period</b>    | From 5 to 28 days.                                                                                                                                                           |
| <b>Mode of Transmission</b> | Hands and water contaminated by the feces and urine of patients and disease carriers.                                                                                        |
| <b>Prevention</b>           | <ul style="list-style-type: none"> <li>* Drink boiled and cooled water.</li> <li>* Wash hands thoroughly with soap before eating food and after using the toilet.</li> </ul> |

|                     |                                                                                                                         |
|---------------------|-------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b> | <b>Typhoid</b>                                                                                                          |
| <b>Category</b>     | <b>Details</b>                                                                                                          |
|                     | <p>* Disinfect vomit and feces using a disinfectant.</p> <p>* Conduct super-chlorination of drinking water sources.</p> |

|                             |                                                                                                                                                                                                                                                                                       |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Poliomyelitis / Infantile Paralysis</b>                                                                                                                                                                                                                                            |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                                                        |
| <b>Major Symptoms</b>       | Fever, headache, body aches, chills, weakness/paralysis in the legs as a symptom of palsy, difficulty bending forward, and weakness in the limbs (arms and legs).                                                                                                                     |
| <b>Causative Agent</b>      | Enterovirus (mainly affects the nervous system, including the motor neurons of the spinal cord and brainstem).                                                                                                                                                                        |
| <b>Incubation Period</b>    | From 7 to 14 days (can range from 2 to 21 days).                                                                                                                                                                                                                                      |
| <b>Mode of Transmission</b> | Primarily transmitted through the fecal-oral route. It can also spread through secretions from the nose and throat.                                                                                                                                                                   |
| <b>Prevention</b>           | <p>* Administering Oral Polio Vaccine (OPV) drops and Inactivated Polio Vaccine (IPV) injections to all children as part of routine immunization.</p> <p>* Due to the Pulse Polio program conducted at the national level, no polio cases have been reported in India since 2011.</p> |

**Other Major Infectious Diseases**  
**Airborne**

|                             |                                                                                                                                                                                                 |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Tuberculosis / TB</b>                                                                                                                                                                        |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                  |
| <b>Major Symptoms</b>       | Cough lasting for more than two weeks, weight loss, low-grade fever at night, loss of appetite, etc.                                                                                            |
| <b>Causative Agent</b>      | <i>Mycobacterium tuberculosis</i>                                                                                                                                                               |
| <b>Incubation Period</b>    | Usually three weeks (this can also extend to months or years).                                                                                                                                  |
| <b>Mode of Transmission</b> | Through the air via droplet nuclei (when coughing, sneezing, or speaking loudly).                                                                                                               |
| <b>Prevention</b>           | <p>* BCG vaccination.</p> <p>* Early detection, screening, and treatment of infected individuals.</p> <p>* Screening and prophylactic/preventive medication for close contacts of patients.</p> |

|                             |                                                                                        |
|-----------------------------|----------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Diphtheria</b>                                                                      |
| <b>Category</b>             | <b>Details</b>                                                                         |
| <b>Major Symptoms</b>       | Fever, a greyish membrane/layer in the throat, and difficulty breathing.               |
| <b>Causative Agent</b>      | <i>Corynebacterium diphtheriae</i>                                                     |
| <b>Incubation Period</b>    | 2 to 6 days.                                                                           |
| <b>Mode of Transmission</b> | Through the air; the disease spreads through patients or carriers.                     |
| <b>Prevention</b>           | Routine childhood immunization using vaccines such as the Pentavalent vaccine and DPT. |

|                             |                                                                                                                                                                                                                              |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Chickenpox</b>                                                                                                                                                                                                            |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                               |
| <b>Major Symptoms</b>       | Fever, appearance of blisters/rashes on the body, and successive eruptions of new ones.                                                                                                                                      |
| <b>Causative Agent</b>      | Varicella Zoster Virus                                                                                                                                                                                                       |
| <b>Incubation Period</b>    | From 7 to 21 days.                                                                                                                                                                                                           |
| <b>Mode of Transmission</b> | Through the air.                                                                                                                                                                                                             |
| <b>Prevention</b>           | <ul style="list-style-type: none"> <li>* Isolate the patient from others until 6 days after the onset of symptoms.</li> <li>* Disinfect contaminated clothing and materials.</li> <li>* Vaccination is available.</li> </ul> |

|                             |                                                                                                                                                                                                                                                                                        |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>H1N1 Influenza</b>                                                                                                                                                                                                                                                                  |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                                                         |
| <b>Major Symptoms</b>       | Fever, cough, sore throat, headache, body aches; some individuals may experience vomiting and diarrhea.                                                                                                                                                                                |
| <b>Causative Agent</b>      | Influenza Virus                                                                                                                                                                                                                                                                        |
| <b>Incubation Period</b>    | From 3 to 15 days.                                                                                                                                                                                                                                                                     |
| <b>Mode of Transmission</b> | Through the air.                                                                                                                                                                                                                                                                       |
| <b>Prevention</b>           | <ul style="list-style-type: none"> <li>* Use a handkerchief or tissue paper when coughing or sneezing, dispose of them safely, and wash hands thoroughly with soap.</li> <li>* Pregnant women, the elderly, and individuals with co-morbidities must exercise high caution.</li> </ul> |

|                             |                                                                                                                                                                                                                                                            |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Pertussis / Whooping Cough</b>                                                                                                                                                                                                                          |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                             |
| <b>Major Symptoms</b>       | Severe, paroxysmal cough that ends with a characteristic distinct sound (whoop); occasionally, blood may be coughed up.                                                                                                                                    |
| <b>Causative Agent</b>      | <i>Bordetella pertussis</i>                                                                                                                                                                                                                                |
| <b>Incubation Period</b>    | 7 days (can range from 10 to 20 days).                                                                                                                                                                                                                     |
| <b>Mode of Transmission</b> | Through the air.                                                                                                                                                                                                                                           |
| <b>Prevention</b>           | <ul style="list-style-type: none"> <li>* The disease can spread via secretions from the patient's nose and throat, or through contaminated clothes and toys.</li> <li>* Routine childhood immunization using vaccines like Pentavalent and DPT.</li> </ul> |

|                             |                                                                                                                                                                                                                                                  |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Leprosy</b>                                                                                                                                                                                                                                   |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                   |
| <b>Major Symptoms</b>       | Hypopigmented or pale skin patches with loss of sensation, small nodules visible on or under the skin, thickening of nerves under the skin, and long-standing painless ulcers.                                                                   |
| <b>Causative Agent</b>      | <i>Mycobacterium leprae</i>                                                                                                                                                                                                                      |
| <b>Incubation Period</b>    | 2 to 10 years.                                                                                                                                                                                                                                   |
| <b>Mode of Transmission</b> | Close contact with patients, droplet infection. <i>Note: The text under transmission includes management/care notes like seeking regular treatment, patients wearing gloves, taking care to prevent injuries to limbs, and wearing slippers.</i> |

|                     |                                                                                                                                                                                                                                                                                                                                                              |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b> | <b>Leprosy</b>                                                                                                                                                                                                                                                                                                                                               |
| <b>Category</b>     | <b>Details</b>                                                                                                                                                                                                                                                                                                                                               |
| <b>Prevention</b>   | <p>The disease can spread through secretions from the patient's throat and nose, or through contaminated clothes and toys. Routine childhood immunization with vaccines like Pentavalent and DPT.</p> <p><i>(Note: This prevention section appears to be a misprint/repetition from the Whooping Cough block in the original Malayalam text source).</i></p> |

|                             |                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Disease Name</b>         | <b>Rubella</b>                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Category</b>             | <b>Details</b>                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Major Symptoms</b>       | <p>Skin rashes that look like fine sand/measles, fever, joint pain, swelling of lymph nodes behind the neck, and redness of the eyes. If contracted by pregnant women, there is a very high probability of congenital anomalies affecting the fetus's heart and brain, as well as conditions like blindness, deafness, intellectual disability, and cardiovascular diseases (Congenital Rubella Syndrome).</p> |
| <b>Causative Agent</b>      | Rubella Virus / Rubi Virus                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Incubation Period</b>    | From 14 to 21 days.                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Mode of Transmission</b> | Through the air.                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Prevention</b>           | Administering the MMR vaccine to infants and the Rubella vaccine to adolescent girls.                                                                                                                                                                                                                                                                                                                          |

## **Waterborne Diseases**

### **Antimicrobial Resistance (AMR)**

Antibiotics were a revolutionary discovery in modern medicine. This discovery, which saved the lives of crores of people, led to a massive leap forward in the healthcare sector. Antibiotics have played no small role in substantially increasing human life expectancy, which averaged around 46 years at the beginning of the twentieth century. Antimicrobials are medicines used to prevent and treat infections in humans, animals, and plants.

Antimicrobial Resistance (AMR) is a condition where the internal structure of bacteria, viruses, fungi, and parasites changes over time, causing them to stop responding to medicines. This makes infections difficult to treat, increasing the risk of disease spread, severe illness, and death. A prime example of this is bacteria developing resistance against antibiotics. Certain microorganisms have developed resistance to medicines that were once highly effective against them.

Resistance in bacteria can occur naturally through genetic mutations or when one species acquires resistance from another. Resistance can be acquired naturally due to random biological mutations. Furthermore, this also occurs through the spread of resistant genes via horizontal gene transfer. The uncontrolled use of antibiotics drives mutations (biological changes) that can render antibiotics ineffective. By the year 2050, the number of deaths due to antimicrobial resistance is projected to increase significantly, surpassing deaths caused by other diseases or accidental fatalities.

World Antimicrobial Resistance Awareness Week (WAAW) is a global campaign conducted annually to improve awareness and understanding of AMR among the general public, One Health workers, and healthcare policy-making officials, as well as to promote best practices for disease prevention.

The **Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP)** has been developed by integrating multiple sectors. It addresses numerous activities necessary to effectively tackle the challenges posed by AMR. The integration of KARSAP with One Health initiatives forms a major component of the activities under the Aardram Campaign.

### **Appropriate Use of Antibiotics**

Medical practitioners must follow the AWaRE matrix. The AWaRE classification of antibiotics was developed by the WHO in 2017. According to this, antibiotics are classified into three distinct groups: Access, Watch, and Reserve.

In the 2021 update of the AWaRE classification, 78 previously unclassified antibiotics were added, bringing the current total to 258 antibiotics included in the AWaRE matrix.

This matrix serves as a valuable tool for monitoring antibiotic consumption, defining targets, and evaluating the outcomes of policies aimed at ensuring the correct use of antibiotics and controlling antimicrobial resistance. The World Health Organization's 13th General Programme of Work (2019–2023) recommends that at least 60% of total national antibiotic consumption should come from the **Access** group of antibiotics.

Reference: <https://www.who.int/publications/i/item/2021-aware-classification>

### **Self-Medication**

Purchasing medicines directly without a doctor's prescription, adjusting dosages without medical advice, or failing to take medicines in the prescribed order all contribute significantly to antimicrobial resistance. Furthermore, the unscientific disposal of used or expired medicines allows pharmaceuticals to enter the human body indirectly through contaminated water, fish, and meat. This mismanagement causes life-saving drugs to become ineffective during critical medical emergencies because the pathogens have already acquired resistance against them. Using someone else's prescription for oneself is another highly dangerous practice.

### **Misconceptions and Incorrect Practices**

- Stopping medication as soon as symptoms subside.
- Making self-treatment decisions based on online references.
- Demanding antibiotics or injections even for minor fevers.
- Administering antibiotics to children on one's own initiative for their illnesses.
- Burying leftover medicines in the soil after recovering from an illness.
- Harboring unfounded anxiety regarding medication side effects.

### **The Correct Approach**

- Self-medication must be strictly avoided.
- Healthcare institutions must strictly ensure the implementation of an antibiotic policy.
- Complete the entire course of medication according to the doctor's instructions, even if symptoms disappear early.
- Maintain timely follow-up visits with the doctor.

Healthcare facilities must ensure the proper collection and disposal of used and expired medicines. Coordinated efforts at the grassroots level must be established to implement interventions that halt the misuse of antimicrobials in poultry farming, aquaculture, and animal husbandry.

### **Key Preventive Guidelines**

To prevent the onset and spread of infectious diseases, strict adherence to personal hygiene, food safety, safe drinking water practices, and environmental sanitation must be ensured.

- Caregiver Hygiene: Individuals involved in patient care must maintain rigorous personal hygiene and follow standard infection control precautions.
- Hospital Visits: Avoid unnecessary hospital visits and patient contact to minimize exposure risks.
- Seasonal Preparedness: Ensure timely advance preparations against seasonal outbreaks characteristic of specific periods throughout the year to effectively halt disease transmission.
- Hand Hygiene: Cultivate and actively promote the habit of regular handwashing among children.

- Regulatory Compliance: Utilize the provisions of public health legislation to enforce standards for food safety, drinking water security, market sanitation, and systematic waste disposal.

#### **Preventive Measures and Interventions**

- Leptospirosis Prevention: Administer **Doxycycline** prophylaxis to individuals engaged in cleaning activities, sanitation work, or anyone coming into direct contact with stagnant, waterlogged areas. Promote and encourage the timely vaccination of domestic animals and livestock.
- Immunization Awareness: Educate and raise awareness among the general public regarding routine childhood vaccination schedules, emphasizing the utilization of vaccine-preventable opportunities, such as administering the Chickenpox vaccine.

## **Department of Agricultural Development and Farmers' Welfare**

Agriculture is the practice of cultivating plants, fungi, and other life forms for food, fiber, biofuels, medicinal plants, and other products used to sustain and enhance human life. Modern agricultural science, plant breeding techniques, pesticides, chemical fertilizers, and the use of agrochemicals alongside improved technologies have been instrumental in sharply increasing crop yields.

At the same time, the excessive and unscientific use of these components has led to widespread environmental issues and adversely affected human health. The major problem currently faced by farmers in Kerala is the attack of various pests and diseases across all types of agricultural crops. The impact and severity of these pest and disease outbreaks vary depending on the weather, soil, and other environmental factors. Developing a clear understanding of these variables through the promotion of better agricultural practices is essential for farmers. The rise in pest infestations and crop diseases remains one of the primary reasons for reduced crop productivity.

### **Green Revolution - In India**

The Green Revolution refers to the industrial and cultural transformation that took place in the Indian agricultural sector with the objective of achieving self-sufficiency in food production. Through the utilization of high-yielding variety (HYV) seeds, agricultural mechanization, advanced irrigation methods, pesticides, and chemical fertilizers, the production capacity of the agricultural sector was substantially increased. However, the excessive and unscientific use of these practices has now created highly detrimental conditions for humans, animals, and nature alike.

### **Various Types of Pesticides**

- Biopesticides

Biopesticides are naturally occurring substances derived or manufactured from plants or plant parts. They are primarily formulated by blending natural ingredients like neem, tulsi (holy basil), tobacco, bird's eye chili, and garlic with other organic materials. Pungent plants or plant parts possessing strong odors and sharp characteristics are highly suitable for this purpose.

- Organic Fertilizers / Biofertilizers

Organic fertilizers are those produced from or containing materials such as organic compost, cattle manure, poultry droppings, domestic waste, and organic waste matter.

\* Biofertilizers / Microbial Fertilizers (ജൈവജീവാണുവളങ്ങൾ)

Biofertilizers are products containing living microorganisms that are applied to the soil or plants to promote growth. In other words, biofertilizers are active microbial formulations capable of fixing atmospheric nitrogen or solubilizing insoluble soil phosphorus into forms that plants can readily absorb.

- **Examples:** *Pseudomonas*, *Rhizobium*.

- Chemical Pesticides

Chemical compounds used to kill, sterilize, or repel pests are generally called chemical pesticides. Synthetic chemical pesticides are of various types, including organochlorines, organophosphates, carbamates, and pyrethroids. When all other integrated pest management (IPM) methods fail, chemical pesticides must be applied with extreme caution, strictly adhering to all safety guidelines, to control pests and prevent economic loss.

- Chemical Fertilizers

Chemical fertilizers are man-made or naturally processed substances applied to plant tissues or soil to supply essential nutrients required for plant growth.

Examples: Urea, Potash fertilizers.

- Pesticide and Fertilizer Safety Parameters

Approved agricultural manuals contain systematically structured guidelines detailing the exact dosage, application methods, and timing schedules for every type of pesticide and fertilizer, established through years of extensive field research.

- EIL (Economic Injury Level): The Economic Injury Level (EIL) is defined as the lowest pest population density that will cause economic damage to a farmer.
- ETL (Economic Threshold Level): The Economic Threshold Level (ETL) is the pest population density at which control measures should be initiated to prevent the population from reaching the Economic Injury Level. If management interventions are not implemented at this stage, economic loss and crop damage are certain to occur.

Every pesticide has a specific residual period during which its toxicity persists on plants after application. If this waiting period (pre-harvest interval) and the harvest schedule are strictly synchronized and managed, crops with minimal toxic residues can be harvested. By scheduling the harvest such that pesticide residues degrade naturally below harmful limits after a pest control intervention, toxic-free agricultural products can be obtained.

## **Adverse Ecological Effects of Agrochemical Misuse**

### **1. Destruction of Beneficial Insects**

For every pest species in nature or within a food web, there are natural predators and enemies. These organisms act as the farmer's natural biological control agents by keeping pest populations in check.

Examples: *Trichogramma* (parasitoid wasps), spiders.

### **2. Soil, Air, and Water Pollution**

Soil pollution occurs when the application of chemical pesticides exceeds permissible thresholds. This causes the destruction of beneficial soil microorganisms, alters soil structure, and results in a loss of fertility. Similarly, the excessive use of chemical fertilizers and

pesticides leads to run-off that pollutes water bodies, creating severe public health and environmental hazards for humans, livestock, and aquatic life.

### **3. Pest Resurgence and Secondary Pest Outbreaks**

Chemical pesticides frequently kill non-target, beneficial predatory organisms alongside target pests. In certain instances, chemical applications destroy natural natural predators while leaving some target pests alive. Free from predatory pressures, these target pests multiply at an accelerated rate.

A comparative study evaluating organic biocontrol methods against synthetic pyrethroid applications on diamondback moths (a primary pest in the cabbage family) demonstrated that a drop in beneficial predator counts directly caused an explosion in the destructive pest population.

Conversely, the outcome was highly favorable under organic biocontrol management. When a pest population rebounds to levels equal to or greater than those existing prior to chemical intervention due to the eradication of its natural enemies, the phenomenon is termed **Pest Resurgence**.

This loss of predatory species can also trigger a **Secondary Pest Outbreak**, where minor insect species—which previously caused no economic damage—multiply unchecked due to the depletion of their natural predators, emerging as dangerous new primary pests.

### **Operational Protocols for Officials During Field Visits**

**Farmer Sensitization:** Educate and raise awareness among farmers regarding the critical importance of reporting disease or pest outbreaks to agricultural officials in a timely manner.

1. **Inter-Departmental Collaboration:** Coordinate and organize joint field visits with experts from various relevant departments—including Health, Local Self-Government, Agriculture, Animal Husbandry, Dairy Development, and Fisheries—to evaluate ongoing ground-level issues, review reports, and recommend appropriate remedial interventions.
2. **Vector Monitoring & Habitat Surveillance:** Conduct thorough field-level inspections to determine if environmental conditions are conducive to the proliferation of disease-carrying vectors. If such conditions exist, immediate vector control and preventive measures must be executed. Additionally, inspect the area to identify whether risk factors for specific regional outbreaks (e.g., Leptospirosis) are actively present.

### **Integrated Pest and Disease Management - IPDM**

Pests have been a persistent threat to agriculture since the dawn of cultivation. Historically, farmers adopted various traditional pest control methods to mitigate damage and improve crop yields. However, the discovery and introduction of synthetic chemical pesticides at the beginning of the last century fundamentally altered agricultural practices.

Initially, the combination of high-yielding crop varieties, intensive chemical fertilizer application, and chemical pesticides sparked a major production revolution across the agricultural sector. Over time, however, the repeated and continuous use of these chemical inputs began to yield severe ecological consequences, giving rise to profound environmental degradation and serious public health issues.

According to global data compiled by the World Health Organization (WHO), developing countries account for only about 20% of global pesticide consumption, yet they suffer an astonishing 80% of world fatalities attributed to pesticide poisoning. Confronted with this alarming reality, the necessity for an alternative strategy emerged. This drove the development and prioritized adoption of Integrated Pest Management practices designed to minimize chemical dependency.

IPDM relies on the careful selection and systematic integration of diverse pest management methodologies based on the specific ecological requirements of the crop. The core objective is to suppress pest populations below economically damaging thresholds using measures that cause minimal disruption to the surrounding ecosystem, ensuring safety for humans, animals, and non-target organisms. Field implementations across a wide variety of crop cultivation profiles have conclusively demonstrated that this comprehensive approach is highly successful and economically viable.

### **The Limitations of Chemical Dependence**

Farmers must recognize a vital biological reality: while synthetic chemical pesticides offer rapid, short-term suppression of pest populations, their efficacy is inherently short-lived. Paradoxically, the recurrent application of these chemicals accelerates natural selection pressures, allowing target species to develop high levels of biological resistance. Globally, approximately 450 insect pest species, 100 fungal pathogens, and nearly 50 weed species have already developed documented resistance to common chemical treatments.

Furthermore, the unscientific and excessive use of toxic sprays inadvertently eradicates beneficial predatory insects and natural biological control agents native to the ecosystem. Stripped of natural predatory checks, minor insect populations that previously caused negligible economic damage often multiply unchecked, transforming into highly destructive primary pests. Because of this cycle of resistance and ecological imbalance, the long-term returns on chemical investments diminish over time, eventually rendering the interventions completely ineffective.

It was under these circumstances that plant protection scientists came forward to develop an effective, long-lasting, and eco-friendly pest control method. Scientists reached the conclusion that all living organisms are necessary on Earth, that they cannot be completely eradicated, and that attempting to do so would cause more harm than good. As a result, experimental observations proved that Integrated Pest Management (IPM) is the most suitable method, as it does not destroy natural enemies but keeps pests below a threshold level without causing a reduction in crop yield.

**There are mainly 6 methods in Integrated Pest Management:**

1. Cultural Method
2. Mechanical Method
3. Physical Method
4. Legal Method
5. Biological Method
6. Chemical Method

### **1. Cultural Method**

The cultural method is a practice of farming in accordance with the climate by making variations in agricultural practices, using high-quality seeds, and maintaining environmental hygiene.

### **2. Mechanical Method**

Pest control is made possible using various types of traps.

### **3. Physical Method**

Disease control is made possible through physical means. Examples include soil solarization and drying grains for storage.

### **4. Legal Method**

Legal mechanisms and regulations are utilized to prevent the transport and transfer of infected seeds, weeds, and pests.

### **5. Biological Method**

A method where pest control is achieved by utilizing friendly insects (beneficial insects) and friendly fungi (biocontrol agents).

### **6. Chemical Method**

Pest control using chemical pesticides is a method used only when none of the above-mentioned methods are viable or successful.

By integrating all these methods, **Integrated Pest Management** stands out as the best approach to farming, as it minimizes the harmful effects on nature, humans, and animals.

## **Department of Animal Husbandry**

### **Zoonotic Diseases**

Zoonotic diseases are those that can be transmitted between humans and animals. These diseases are caused by pathogens such as viruses, bacteria, parasites, and fungi. Diseases like Rabies, Nipah, and Leptospirosis (rat fever) can be severe and life-threatening, while some others are mild and self-limiting. So far, more than 1,415 pathogens affecting humans have been identified. This includes 217 viruses and prions, 538 bacteria and rickettsiae, 307 fungi, 66 protozoa, and 287 helminths (internal parasites). Among these known diseases, 868 (61%) are zoonotic. However, humans act as the primary host for only 3% of them. Among "emerging diseases," 75% are zoonotic.

Understanding and preventing Antimicrobial Resistance (AMR), which poses a threat to public health and development, is essential. Furthermore, because major modern-day challenges like global warming and climate change contribute to the emergence and re-emergence of zoonotic diseases, they severely affect public health.

Biosecurity refers to the actions taken to protect the health of humans, animals, and the environment from zoonotic pathogens. Knowledge about biosecurity and its implementation will help prevent the onset and spread of diseases.

### **Viral Diseases**

#### ***Rabies***

Rabies is the most important zoonotic disease affecting both humans and animals. It is a viral disease that is 100% fatal but 100% preventable. Around 60,000 deaths occur worldwide every year due to rabies. Out of this, around 20,000 deaths occur in India alone. Children account for 40% of these cases.

#### **Cause of the Disease:**

This disease is caused by the Lyssavirus, which belongs to the Rhabdoviridae family.

#### **Animals Affected by the Disease:**

This disease can affect all warm-blooded animals. In our country, it affects domestic animals like dogs, cats, cattle, goats, pigs, and horses, as well as wild animals like foxes, wolves, monkeys, and mongooses. The disease is very rarely seen in small animals like squirrels and rabbits. This disease does not normally affect the avian species (birds) or insects. Although the disease is found in bats in Western countries, it has not yet been detected in bats in India.

#### **Disease Carriers (Vectors)**

Dogs, cats, mongooses, foxes, and wolves are the primary carriers of this disease in our country. It is estimated that approximately 97% of rabies cases in humans in India are caused by dogs. In several Western countries, bats are seen as carriers of the disease.

## How the Disease Spreads

The disease spreads through the bite or scratch of an infected animal, or when their saliva comes into contact with mucous membranes. The virus, which enters the body through wounds or saliva, multiplies in the muscles and later travels through the nervous system to reach the brain. Once it reaches the brain, it causes inflammation of the brain (encephalitis) and symptoms begin to show. Subsequently, the virus moves from there to the salivary glands and other organs.

## When Do Symptoms Start to Appear?

Once the pathogen enters the body, symptoms usually manifest within a period ranging from **1 week to 6 months**. Cases have also been reported where symptoms appeared after one or two years. The variation in time taken to show symptoms (**incubation period**) depends on factors such as the proximity of the bite site to the brain, the load of the pathogen, the species of the biting animal, and immunity.

## Symptoms:

Once animals start showing symptoms, death will occur within **2 to 10 days**.

### *Symptoms in Dogs:*

- **Furious Form (Raudra Bhavam):** Aggressive behavior, loss of appetite, aimless wandering, biting at objects like stones and sticks, circling as if trying to catch a fly on the tail, change in voice, and inability to bark.
- **Dumb Form (Manda Bhavam):** Calm demeanor, hiding in the dark, failure to recognize the owner, lower jaw dropping with continuous drooling of saliva, inability to swallow food and water as if something is stuck in the throat, paralysis progressing from the hindquarters, and death.

### *Symptoms in Cats:*

They mostly exhibit furious forms, such as a change in voice and sudden, unprovoked aggressive behavior. They may lose their fear of humans and other animals and might jump up and attack the face or other parts.

### *Symptoms in Cattle:*

Symptoms may include continuous bellowing, change in voice, aggressive behavior, frequent urination, hitting their head against structures, and drooling saliva.

### *Symptoms in Wild Animals:*

Running up and attacking humans and other animals without any reason is a symptom of rabies in wild animals. They completely lose their natural fear of humans.

### *Symptoms in Humans:*

Unbearable pain and itching at the site of the bite, nausea, vomiting, fever, severe headache, restlessness, sweating, insomnia, muscle spasms, fear of death, hydrophobia (fear of water), aerophobia (fear of air), and death due to respiratory failure.

## **Precautions to Prevent the Disease**

- Take care to avoid getting bitten by animals.
- If bitten, wash the wound thoroughly. (Wash for 15 minutes under running tap water). Savlon, Iodine, or Spirit can be applied. Do not apply any traditional home remedies or powders to the wounds.
- Reach the nearest Community Health Centre or hospital as quickly as possible and seek medical treatment immediately.
- Observe the biting animal (dog, cat) for 10 days. If it shows symptoms of the disease or dies, conduct a laboratory test to diagnose the disease.

## **Ways to Avoid Dog Bites**

- Avoid interacting with stray dogs (even if they appear friendly).
- Do not throw stones at dogs or try to chase them away.
- Do not disturb dogs while they are eating, when they are with their newborn puppies, when they are sleeping, or when they are sick.
- Avoid staring directly into a dog's eyes.
- If a dog runs up behind you, stand perfectly still.
- Do not provoke or harm dogs, even if it is a pet raised in your own home.
- Take care to avoid getting bitten on the face.

## **If a Domestic Animal (Pet) Gets Bitten**

- Wash the wound thoroughly using soap and water.
- Apply Iodine to the wound.
- Seek treatment as per a veterinarian's instructions. Administer the Tetanus toxoid injection and vaccination according to the veterinarian's advice.
- Do not stitch/bandage the wound.
- Ensure that your pet dogs and cats are given preventive vaccines every year without fail.
- If bitten by a dog that has been vaccinated, a stray dog, or a dog suspected of having rabies, seek the advice of a veterinary doctor; take measures such as isolating the animal and administering a booster vaccination.

## **Diagnosis**

Facilities are available in Kerala at **7 centers** to conduct rabies diagnosis. Diagnosis facilities are available under the Department of Animal Husbandry at Rabies Diagnostic Labs located in Thiruvananthapuram (Palode), Kollam, Pathanamthitta (Thiruvalla), Palakkad, and Kannur, as well as at the veterinary colleges in Thrissur (Mannuthy) and Wayanad (Pookode). A letter from a veterinary doctor is mandatory. Medical treatment must be obtained immediately after being bitten.

- Do not delay treatment until the test results arrive.
- Once symptoms begin to appear, treatment will not be effective.

## Prevention

The first preventive vaccine for dogs and cats should be given at three months of age, and a booster vaccine should be administered three to four weeks later. Subsequently, booster doses must be given every year.

## Disease Control

To control the disease, managing stray dogs, administering preventive vaccinations to pet dogs, proper waste management, and responsible dog ownership are essential.

## Bird Flu / Avian Influenza

Bird flu, or avian influenza, is a viral disease that affects birds. A type of virus belonging to the Orthomyxoviridae family is the cause of this. Because it spreads rapidly, birds die in large numbers.

A distinct characteristic of bird flu is its potential to spread to humans. Humans who maintain close contact with infected birds are at risk of contracting infections like bird flu.

This disease, which can spread from birds to humans, caused widespread panic across Asia in 2003. The first case of bird flu virus infecting humans was reported in Hong Kong in 1997.

It was in 2006 that the **H5N1** bird flu reached India. Avian flu usually affects birds. Bird flu viruses (avian influenza) are certain variants of the influenza virus, which is the commonly seen common cold virus. Variants such as H5N1 and H5N8 of bird flu have been observed in India over recent years. The H9N2 strain, which has lower virulence (*Low Pathogenic AI*), also causes disease in birds.

## Affected Species

Bird flu, also known as avian flu or avian influenza, is spread by viruses belonging to the **H5** and **H7** variants. These affect birds, chicks, other poultry, wild birds, and waterfowl such as ducks. **Low Pathogenic Avian Influenza (LPAI)**, which has a lower mortality rate, is usually found only in birds. However, **Highly Pathogenic Avian Influenza (HPAI)**, which has a higher destructive capacity, has been found to transmit to humans and many other mammals. How does the Bird Flu Virus Spread? (പക്ഷിപ്പനി വൈറസ് പകരുന്നതെങ്ങനെ?)

Influenza viruses are named using various combinations of the letters H and N. **H1N1**, **H1N2**, and **H3N2** are the influenza virus types known to affect humans. These undergo mutations over time as a result of biological evolution. The type causing the bird flu we currently read about in the news is the **H5N1** influenza virus. This is a widespread viral mutation of the bird flu that was confirmed in Hong Kong in 1997.

When saliva, droppings, and other secretions from infected birds fall in various places, the virus spreads through them. The virus is transmitted to other birds that come into contact with

these waste materials in any way (through water, food, air, etc.). **Migratory birds** are the ones that carry and spread the disease to distant lands.

### **Symptoms in Birds**

The disease condition caused by the virus is not the same in all birds. In some, this virus causes only a mild infection (**Low Pathogenic Avian Influenza**). The only noticeable symptom might be a drop in egg production. The mortality rate is low in this mild condition.

However, the condition we fear the most occurs when the severity of the disease is very high (**Highly Pathogenic Avian Influenza**). If this condition arises, birds will die within approximately **48 to 72 hours**. Sudden, mass deaths are the primary symptom. It also spreads rapidly to nearby birds.

- The mortality rate can be up to **100%** in chickens and turkeys.
- However, the mortality rate is lower in ducks and other waterfowl.
- No symptoms are usually seen in migratory birds.

Other symptoms include swelling of the face, blood spots on the wattle, comb, and legs, blue discoloration, diarrhea, and respiratory difficulties. Drooping of the head and cataracts in the eyes can also be observed. During a post-mortem examination, hemorrhaging (bleeding) can be seen in all internal organs of the body.

### **Bird Flu in Human**

This virus transmits to humans from poultry birds, primarily through contact with their excretory waste materials. Human-to-human transmission of this disease is extremely rare.

Among the humans known to have been infected with this virus so far, symptoms of a common cold and phlegm accumulation have been observed. Symptoms like conjunctivitis (pink eye) have also been reported. Fever, cough, sore throat, and pneumonia can also be seen. Rarely, it can also affect the brain.

### **Diagnosis**

Bird flu cannot be diagnosed solely based on symptoms. Post-mortem examination and PCR (Polymerase Chain Reaction) testing in a laboratory are required.

### **Characteristics of Avian Influenza**

The most alarming thing about these viruses is the changes (mutations) in their genetic structure. What makes this terrifying is that numerous gene combinations can occur during this process. If the newly formed virus changes its aggressive behavior due to these mutating gene sequences, it can transform into a highly severe, fatal pathogen that cannot be stopped by any medicine.

Such viral mutations are often observed in pigs. Suppose two different influenza viruses—one from a bird and one from a human—simultaneously cause an infection in a pig (**co-infection**). In certain instances, these two viruses can merge within a single cell of the pig's body and undergo genetic reassortment. With this, a highly problematic and potentially fatal new type of influenza virus is born.

## Treatment and Preventive Vaccination

Medicines such as Oseltamivir, Zanamivir, and Peramivir are currently used against bird flu. However, as part of disease control, birds are not given treatment. Instead, infected birds and other birds within the surrounding area (**1 km radius**) are culled to control and prevent the disease from spreading.

## Precautionary Measures

The risk of contracting this disease is highest when handling the carcasses of infected animals or objects like eggs. Therefore, farmers, farm workers, and health workers operating in this sector must be cautious. There is no need to fear if the following precautions are taken while handling:

1. After handling poultry meat or eggs, wash your hands thoroughly using soap and water.
2. When washing meat or preparing it, keep it separate from other food items, and use a clean cutting board and knife.
3. Wash the outside of eggs thoroughly. Avoid adding raw eggs to food preparations.
4. Consume eggs only after they are boiled or fried. Avoid consuming half-cooked eggs or bullseye (sunny-side up) eggs. Eat chicken meat only after it is thoroughly cooked.
5. If any health issues are observed in domestic poultry kept in areas frequented by large numbers of migratory birds, it should be considered a warning sign of bird flu. Report it immediately to the nearest veterinary hospital.



## Influenza Virus in Pigs (Swine Flu)

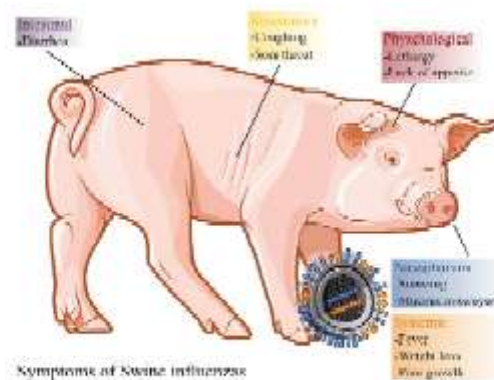
Swine flu is a disease infection caused in host animals by a microorganism known as the influenza virus, which belongs to the Orthomyxoviridae virus family. In English, it is called

**Swine flu, Swine influenza, or Hog flu**, and scientifically it is referred to as **A/H1N1 Influenza**. Pigs and humans are the primary hosts. Although these viruses rarely transmit from pigs to humans, they usually do not cause a large-scale outbreak affecting many people.

The virus does not spread by consuming pork. The disease occurs in humans who interact very closely with infected pig farms, depending on their individual immunity levels.

### Symptoms

- In **humans**,
- the symptoms of the disease include fever, body aches, headache, sore throat, and cough. Sometimes, the patient may also experience diarrhea and vomiting.
- In **pigs**, symptoms may include a cough, mild breathing difficulties, diarrhea, and fever.



**N.B:** The **H1N1** virus that is currently reported from time to time in our region is a contagious disease that spreads **from human to human**. Although the origin of this disease was initially in pigs, pigs play no role in the transmission cycle occurring now. Therefore, this disease is no longer called "Swine Flu" today.

## Japanese Encephalitis

### Disease Definition

Japanese Encephalitis (JE), commonly known as Japan Jwaram, is a type of brain fever (encephalitis) spread by mosquitoes. This disease, which is predominantly found on the Asian continent, mainly affects humans, pigs, and horses.

### Cause of the Disease

The causative agents of this disease are viruses belonging to the **Flavivirus** category. In our region, the primary disease vectors are **Culex mosquitoes**. The virus multiplies in large quantities inside infected pigs, making them act as a source of infection for other living beings, including humans. Therefore, pigs are considered the **amplifying hosts** of Japanese Encephalitis. Certain waterfowl serve as **reservoir hosts**, helping to maintain this virus in nature.

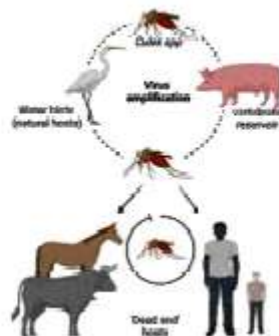
### Morbidity / Mortality Rate

Every year, around **68,000** clinical cases of Japanese Encephalitis are reported from various countries across Asia. In India, this epidemic is most seen during the period from **May to October**.

- In horses, the morbidity rate is between **1% and 1.4%**. However, during outbreaks, it can reach **30% to 40%** and can also lead to death.
- Up to **70%** of infected pigs suffer from reproductive disorders, including abortions. The mortality rate among infected piglets can be up to **100%**. At the same time, Japanese Encephalitis is rarely fatal in adult pigs.
- In humans affected by the disease, permanent neurological damage or mental disorders are observed in more than **50%** of cases. Among those who develop encephalitis (brain swelling) as a symptom, the mortality rate can rise to **30%**.

### Affected Species

Apart from primarily affecting humans and horses, this disease also affects pigs. In other domestic animals, it is additionally seen as an asymptomatic, subclinical infection. Although JE primarily affects children, individuals of any age group can contract this disease. It has been observed that natural immunity develops after an infection.



### Mode of Transmission

According to the report of the World Health Organization, JE is naturally persistent (**endemic**) in 24 countries across Southeast Asia and the Western Pacific region. Although the Japanese Encephalitis virus has been found in various species of mosquitoes, **Culex mosquitoes** are the primary disease vectors in our region. Pigs act as the **amplifying host**. Waterfowl are the **reservoir hosts** that help maintain this virus in nature.

The virus survives through a disease transmission cycle involving mosquitoes, pigs, and waterfowl. Further spread of the disease **does not occur** from humans or horses. Therefore, they are considered **dead-end hosts**. Symptoms begin to appear between **4 to 14 days** after being infected by the virus.

## Symptoms in Humans and Animals

### In Humans:

Most Japanese Encephalitis infections do not show manifest symptoms. However, fever and headache are commonly seen. In some patients, especially in children, severe clinical disease is observed. In children, abdominal pain and vomiting are the initial symptoms. The characteristics of the severe form of the disease include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, paralysis, and eventually death. Among the survivors, 20% to 30% suffer from permanent neurological disabilities, such as paralysis and loss of speech.

### In Animals:

In horses, the symptoms include an acute fever lasting for 2–4 days, loss of appetite, depression, difficulty swallowing, neck stiffness, blindness, and paralysis. As the disease becomes severe, high fever is accompanied by restlessness, muscle twitching, aimless wandering, and changes in behavior. Ultimately, aggression, blindness, coma, and death (5% mortality rate) can occur, along with neurological disabilities.

In pigs, JE usually manifests as a **reproductive disease**; the reproductive failure rate can be 50–70%. Abortions, stillborn piglets, and mummified fetuses are common. Surviving piglets exhibit neurological symptoms, tremble, and die within a few days. In grown adult pigs, no manifest symptoms are seen other than a mild fever. In male boars, it severely affects sperm production.

## Diagnosis

JE may be suspected in individuals who exhibit brain fever (encephalitis) symptoms and either live in or have travelled to an endemic area.

- Animals living near their residential areas, especially pigs, must be subjected to examination. JE must be differentiated from other diseases showing similar symptoms, such as West Nile Encephalitis, African Horse Sickness, Equine Infectious Anemia, Rabies, Tetanus, Swine Flu, PRRS (Porcine Reproductive and Respiratory Syndrome), Pseudorabies, Dengue fever, and Yellow fever.
- Testing for JEV-specific antibodies is conducted on samples of Cerebrospinal Fluid (CSF) or serum using the ELISA method.
- Testing can also be conducted via the RTPCR method on blood samples or brain tissue samples (from deceased animals).

## Treatment

There is no specific treatment for the disease. Treatment focuses on giving supportive therapy to the patient to manage the infection and help them recover from severe clinical symptoms.

## Prevention and Control

- Safe and effective vaccines against JE disease are available for humans.

- Mosquito control deserves the highest priority.
- Strengthen disease surveillance and reporting systems in both humans and animals.
- Vaccination is highly essential in areas with environmental conditions suitable for the transmission of the JE virus.
- Travelers spending extended periods in JE-endemic areas should receive the vaccination before traveling.
- Personal protective measures to avoid mosquito bites include wearing long-sleeved clothes and using mosquito coils and vaporizers.
- Vaccination should be considered for pigs and horses. Vaccinating pigs prevents reproductive failures and directly halts JE viral amplification. However, vaccines for animals are not widely available in our country.
- House animals inside farms and rear them by conducting medical check-ups at regular intervals.
- Maintain farms by utilizing larvicides, mosquito repellents, and fans.
- Do not house animals susceptible to the disease together, especially pigs and horses.
- Bird-proof netting can be installed in pig farms.

### **West Nile Fever (West Nile Jwaram)**

West Nile Fever is a brain fever (encephalitis) caused by flaviviruses known as West Nile Virus (WNV). Mosquitoes belonging to the **Culex** group are the primary vectors transmitting this disease. Birds are the main host animals for this virus. The disease persists in nature through a cyclic transmission pattern between mosquitoes and birds.

#### **Cause and Transmission of the Disease**

- The disease is caused by the **West Nile Virus**.
- The virus persists through transmission from birds, which are its natural host animals, to other birds via mosquito bites.
- WNV can affect various types of avian and animal species. It has been found capable of infecting humans, other primates (monkeys), horses, dogs, cats, and at least **30 other mammalian species**.
- The disease manifests explicitly in humans and horses; however, symptoms are rarely seen in dogs and cats.
- Certain species of crocodiles, alligators, snakes, lizards, frogs, and other reptiles and amphibians can also become infected. Because infected mammals do not develop high levels of the virus in their blood (viremia), mammalian infection is considered accidental.
- The disease can also spread through direct contact with birds, consuming the meat of an infected bird, or drinking water contaminated with the pathogen.

- It has been found that the virus can be transmitted from female mosquitoes to the next generation through their eggs.
- When mosquitoes feed on the blood of infected birds, the virus enters the mosquitoes. Later, when these mosquitoes bite humans or other animals, the viruses enter their bodies.
- Rarely, the virus can also be transmitted through blood transfusion, organ transplantation, during pregnancy or childbirth, and from mother to child during breastfeeding.
- This disease **does not spread from human to human** under any circumstances.

### Symptoms in Humans

- Even if infected, **80% of humans** do not develop any significant symptoms.
- Around **20% of humans** show primary symptoms such as fever, headache, and vomiting.
- In less than **1% of infected individuals**, severe symptoms manifest. These individuals exhibit symptoms of encephalitis (inflammation of the brain) or meningitis (inflammation of the protective membranes covering the brain and spinal cord).
- Among those whose nervous system is affected by the disease, approximately **10% die**.

### Disease in Animals

- In **horses**, normally, noticeable symptoms do not usually occur.
- However, symptoms such as difficulty walking (**Ataxia**), **Head Tilt**, muscle spasms (**Muscle Tremors**), encephalitis, and difficulty standing up (**Inability to Rise**) may be observed in some horses.
- In instances where the central nervous system is severely affected, death can occur in horses.
- Several vaccines against WNV are currently available for horses in Western countries.
- In **dogs and cats**, symptoms like fever, weakness in the legs, seizures, and lethargy may be observed.
- Birds such as ducks, chickens, swans, crows, owls, sparrows, and parrots can be affected.
- Similarly, certain species of wild waterfowl and other aquatic birds fall victim to the West Nile disease.
- Symptoms in birds are often indistinct. Emaciation, dehydration, unusual shedding of feathers, weakness, fatigue, standing still with head down, loss of appetite, and lethargy, as well as neurological symptoms (head tilt, squinting/blinking, tremors, paralysis of legs/wings, seizures, blindness), have been reported in birds.
- **Mass deaths of birds, especially crows**, serve as a warning sign.

## Diagnosis of West Nile Virus Infection

- Blood tests
- Antibody testing of Cerebrospinal Fluid (CSF)
- RTPCR

## Prevention and Treatment

- Vaccines are **not available** to prevent West Nile Virus in species other than horses.
- Avoiding mosquito bites is the primary way to prevent infection.
- Take necessary measures to prevent mosquito breeding.
- Identify and destroy mosquito breeding sources and carry out fogging and spraying activities.
- The *Culex* mosquitoes that transmit West Nile virus breed in stagnant, dirty water. Therefore, eliminate situations where dirty water accumulates. Along with this, ensure there are no leakages in drains, septic tanks, and vent pipes.
- The proliferation of mosquitoes can be prevented by avoiding water stagnation in gutters, swimming pools, old tires, and buckets.
- Using mosquito-repelling devices, window screens, and mosquito nets reduces the probability of getting mosquito bites.
- There is no specific treatment for the disease; pain relievers are used as medications to reduce the pain and inflammation caused by the infection.

### Kyasanur Forest Disease (Monkey Fever)

Kyasanur Forest Disease (KFD), commonly known as Monkey Fever, is a viral disease spread by ticks found in the southwestern parts of India. This disease was first reported in 1957 in the Kyasanur forest area of Shimoga in the Western Ghats of Karnataka. In Kerala, this disease is reported in humans almost every year in the Wayanad district.

### Cause of the Disease

A **flavivirus** is the causative pathogen of this disease. Ticks belonging to the species "*Haemaphysalis spinigera*" transmit this disease.

### Disease Transmission

This disease is primarily transmitted to humans through the bite of infected ticks. The disease **does not spread from human to human**.

Monkeys, bats, squirrels, porcupines, rats, and other small mammals, as well as certain species of birds and insects, are carriers of this virus. This epidemic is usually observed from the months of October–November to January–April. This disease causes a high mortality rate in monkeys. Because the virus multiplies in large quantities inside infected monkeys, they are considered the **amplifying host** for the pathogen. There is also a possibility of this disease occurring in animals like cows and goats through tick bites, allowing the pathogen to persist in them.

## Symptoms

### In Humans:

- **First Phase (continued):** Along with these, severe exhaustion, vomiting, and blood in the stool are also observed during the first phase of the disease. In this stage, the patient's lymph nodes may appear swollen, resembling small bubbles under the skin.
- **Second Phase:** After all the clinical symptoms completely subside, a second phase of the disease begins for some patients after 1 to 3 weeks. In this phase, which starts with a high fever and headache, complications like encephalitis, meningitis, and vision loss are observed. Because it affects the brain, prominent symptoms of this stage include neck stiffness that makes it hard to bend the head, disorientation, and tremors.

**In Animals:** This disease is confirmed in both wild monkeys and bonnet macaques. Fever, loss of appetite, diarrhea, and dehydration are the primary symptoms. The mortality rate is extremely high. Bleeding occurs in internal organs as well. Sudden, mass deaths of monkeys—especially in forest areas—must be considered a critical warning sign.

### Diagnosis

The disease can be confirmed by performing a **PCR test** during the initial stage, or an **ELISA test** if it has been several days since the onset of the infection.

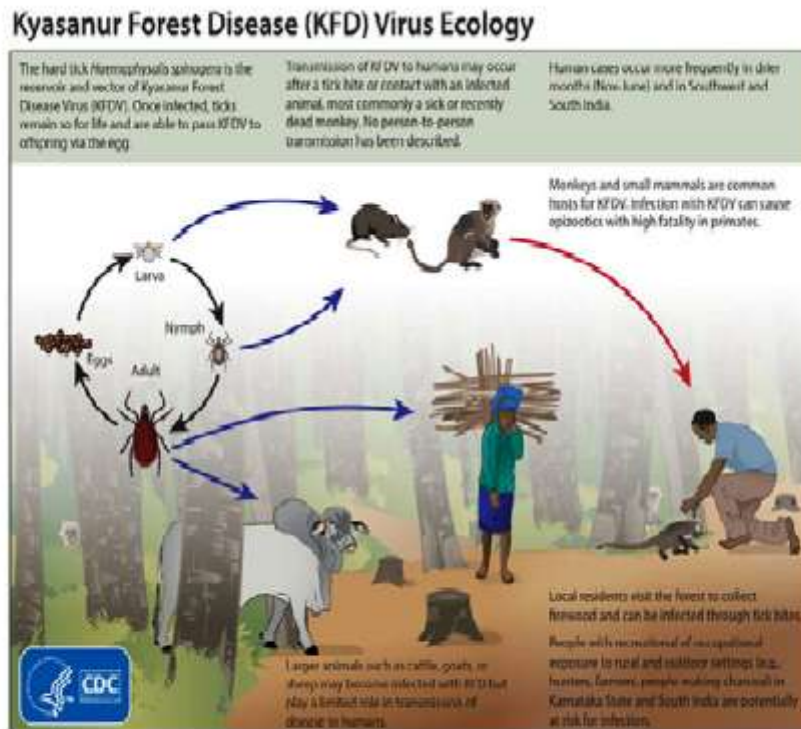
### Treatment

The treatment approach relies on managing the condition based on the specific clinical symptoms present to save the patient's life. Specific anti-viral treatment is **not available**. Treatment methods include administering an intravenous drip to restore fluids lost from the body due to diarrhea and vomiting, medications to stop internal bleeding, providing a protein-rich diet, and ensuring complete rest.

### Prevention

- The probability of contracting a KFD infection is significantly higher for individuals who interact with wildlife, particularly those living in villages near forest areas, or those who frequently visit forest zones in the Western Ghats where Kyasanur Forest Disease is known to spread across interstate borders.
- To remain safe from monkey fever, take strict precautionary measures when visiting forest areas where the disease is actively spreading.
- To reduce the likelihood of tick bites, wear long-sleeved clothes, pants, and closed shoes.
- Apply insect repellents containing Permethrin or DEET on clothing and exposed body parts.
- Avoid direct contact with monkeys and their natural habitats.
- If ticks are found on the body, remove them immediately, and thoroughly clean the bitten area using soap and water.
- Ensure effective tick control by using external parasite control treatments (ectoparasiticides) on domestic livestock.

- Create accurate awareness regarding the disease among children, residents living along forest borders, and individuals engaging in adventure tourism or trekking inside forests.
- Individuals performing post-mortem examinations on monkeys or collecting biological samples must wear protective gear (PPE: Coverall).



## Nipah (NIPAH)

Nipah virus disease is a deadly zoonotic disease (transmitted from animals to humans) that has been affecting mankind since the 1990s. The first human cases were reported in a village called 'Sungai Nipah' in Malaysia, from which the virus and the disease get their name. The Nipah virus infection ranges from asymptomatic (subclinical) infection to acute respiratory infection and fatal encephalitis (inflammation of the brain).

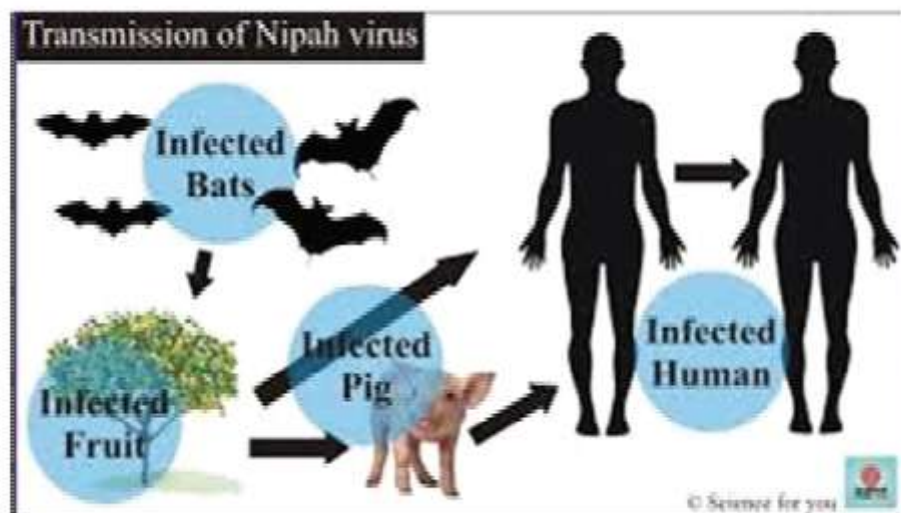
### Cause of the Disease

The causative agents are Henipaviruses, which belong to the Paramyxoviridae family. These are RNA viruses. The infection can be transmitted directly from animals infected with the Nipah virus (such as bats or pigs), from contaminated food, or directly from human to human.



### Morbidity / Mortality Rate

- **In Humans:** The mortality rate is estimated to be between **40% and 75%**. Most people who survive acute encephalitis recover completely; however, long-term neurological conditions have been reported in survivors. Approximately 20% of patients are left with neurological consequences such as seizure disorders and personality changes. A small percentage of people who recover may experience a relapse of encephalitis, which can be fatal.
- **In Animals:** In pigs, the disease is seen with high morbidity but a low mortality rate (<5%). However, the mortality rate is higher in piglets (40%). Bats do not show any severe symptoms of the infection.



### Animals Affected by the Disease

In addition to primarily affecting humans and pigs, Nipah virus infection has also been reported in other domestic animals such as horses, goats, sheep, cats, and dogs. Fruit bats (especially those belonging to the *Pteropus* genus) are the natural carriers of the virus.

## Mode of Transmission

- Consuming fruits or fruit products (such as raw date palm juice) contaminated with urine or saliva from infected fruit bats is the most likely source of infection.
- The infection spreads directly from human to human through close contact with the secretions or excretions of infected individuals.
- There is a high possibility of the disease spreading within healthcare settings during treatment procedures (nosocomial transmission).
- The disease can also be transmitted through direct contact with infected pigs (their secretions) or their contaminated tissues.
- Contaminated drinking water, bat fluids, or other fluids and tissues from childbirth (of infected animals) are also potential sources of infection.

## Symptoms in Humans and Animals

In Humans, the incubation period ranges from 4 to 14 days. Initially, infected individuals present with symptoms such as fever, headache, muscle pain, vomiting, and sore throat. This can be followed by dizziness, drowsiness, and encephalitis (brain inflammation). Some people may also experience atypical pneumonia and severe respiratory problems. In severe cases, patients can progress to a coma within 48 hours.

- **In Animals:** In pigs, the infection is highly contagious and can include fever, along with respiratory and neurological problems. Due to severe difficulty in breathing, nasal discharge, and a loud, dry cough, this illness is also known as **"Barking Pig Syndrome"** and **"One-Mile Cough."** It can also cause weakness in the limbs, spastic paresis, and symptoms similar to tetanus. In horses, it shows respiratory and neurological symptoms. In donkeys, the infection does not appear to be fatal or highly contagious. Only limited clinical data is available regarding dogs and cats.

## Diagnosis

- The initial symptoms of Nipah virus infection are not distinct. Because of this, the disease is often not suspected early on, which hinders an accurate diagnosis.
- The disease is confirmed through **RT-PCR** testing of samples collected from throat and nasal secretions, blood, urine, or cerebrospinal fluid (the fluid around the brain).
- **ELISA, TruNat, and PCR** are currently used as screening tools.

## Medical Treatment

There are currently no specific medicines or vaccines available for Nipah virus infection. Intensive supportive care is recommended to treat severe respiratory and neurological complications. For this purpose, **hyperimmune serum or monoclonal antibodies** are being utilized. Some antiviral drugs (such as Ribavirin and Remdesivir) have shown potential benefits.

## **Disease Prevention and Control**

- Healthcare workers caring for patients with suspected or confirmed infections, or handling their samples, must always implement strict infection control precautions (**barrier nursing**).
- Samples taken from humans and animals suspected of having Nipah virus infection should be handled by trained staff working in laboratories with appropriate containment facilities.
- Avoid direct contact with anyone infected with the Nipah virus.
- Fruits should be washed thoroughly and peeled before consumption. Discard any fruits that show signs of being bitten by bats.
- Wash hands thoroughly with soap after handling or caring for animals.
- Establish mechanisms to prevent bats from entering buildings where animals are housed.
- Keep water sources covered and protected to prevent contamination from animal waste or excretions.
- Avoid unnecessary visitors to farms.
- If an epidemic is suspected, the surroundings of the animals must be quarantined immediately.
- Regularly cleaning and disinfecting pig farms using appropriate detergents is highly effective in preventing infection.
- Avoid maximum contact with pigs that are infected or suspected to be infected.
- Culling of infected animals may be necessary to reduce the risk of transmission to humans.
- When establishing new pig farms in local areas, the presence of fruit bats in the region must be considered, and pig pens and feed storage areas should be protected from them.
- Do not feed animals with fruits that show signs of being bitten by bats.
- Avoid encroaching into the natural habitats of bats (e.g., deforestation).
- Since pigs and fruit bats are involved in Nipah virus transmission, a wildlife/animal health surveillance system is absolutely essential.
- A "One Health" framework uniting veterinary, human, and public health sectors will be highly helpful in detecting Nipah cases.

### **Monkeypox (Mpox)**

Monkeypox is a viral zoonotic disease that occurs in both humans and animals. The disease primarily affects monkeys and humans. The disease was first reported in monkeys (in 1958), which is why it was named monkeypox. The cause of this disease is the Monkeypox virus, which is related to the smallpox virus from the *Orthopoxvirus* genus. This is a zoonotic disease.

### **Transmission of the Disease**

The disease is transmitted through direct contact with infected animals or individuals, or through contact with contaminated materials. It can spread by being bitten or scratched by an infected animal, or by consuming its meat. The disease can also spread during the skinning or hunting of infected monkeys. In humans, the disease spreads from person to person through

touch. There is also a possibility that infected humans can transmit the monkeypox virus to animals through close contact.

### **Disease Severity and Mortality Rate**

Although it is generally not life-threatening, individuals with weak immune systems, children, and pregnant women have a higher risk of developing severe illness.

### **Symptoms in Humans**

The symptoms of the disease in humans include rashes on the hands, feet, chest, face, and genitals, along with fever, fatigue, headache, muscle pain, difficulty breathing, and a cough.

### **Mpox in Animals**

The monkeypox virus can infect many types of mammals. In monkeys, "pox" lesions will appear on the skin (face, hands, legs, and paws) just like in humans. Fever, cough, and swelling of the lymph glands can also be seen. A complete picture of the symptoms in other animals is not entirely clear.

### **Diagnosis**

The Mpox virus can be found in infected body fluids, including pox lesions, scabs, and respiratory secretions. Diagnosis can be confirmed through PCR testing using samples taken from the wounds.

### **Treatment and Prevention**

There is no proven specific treatment for this disease; it is usually a self-limiting illness. Avoiding contact with infected animals or animals that are carriers of the virus, and frequently cleaning hands, are key preventive measures.

This is a highly virulent pathogen. It can survive in nature for months under favorable conditions. Therefore, contaminated materials should either be burned or thoroughly disinfected. The smallpox vaccine has been found to be effective against this disease.

Transmission through food has not been confirmed. It is currently considered a contagious disease that is spreading from human to human.

## **Buffalopox**

Buffalopox is a zoonotic viral disease that primarily affects buffaloes and, rarely, cows. The disease can also spread to humans. The causative agent is the Buffalopox virus, which belongs to the *Orthopoxvirus* genus.

### **Symptoms in Animals**

Symptoms include "pox" marks (wart-like lesions) appearing on the udder, teats, and inner thighs, followed by swelling of the udder. Sometimes, lesions may develop all over the body.

The disease is transmitted through contact with infected animals, fly bites, milkers, and milking machines. There is also a possibility of contracting the disease through hospital/veterinary equipment.

### **Symptoms in Humans**

Symptoms include pox/smallpox-like lesions on the forehead, face, fingers, and hands/legs, along with fever. The World Health Organization (WHO) has classified this as an occupational zoonotic disease.

### **Diagnosis**

Symptoms and information regarding contact with infected animals help identify the disease. The infection can be confirmed through a PCR test.

### **Preventive Measures**

The spread of the disease can be controlled by isolating infected animals from healthy ones and avoiding contact with infected individuals.

### **CCHF - Crimean-Congo Hemorrhagic Fever**

Crimean-Congo Hemorrhagic Fever is a disease that causes severe fever and is transmitted through the bites of ticks, which are external parasites. The causative agent is an RNA virus called **Nairovirus**, which belongs to the **Bunyaviridae** family.

### **Transmission / Spread of Disease**

Initially, the disease is transmitted to humans by ticks (primarily *Hyalomma* species) found as ectoparasites on most animals. Later, it can spread from human to human through direct contact without the tick acting as an intermediary. It has been found that ticks can transmit the virus across generations (trans-ovarian transmission).

The disease can also spread through contact with the blood or meat of animals during and after slaughter. Hospital-acquired (nosocomial) infections can occur due to improper sterilization of medical equipment, reuse of needles, and contamination of medical supplies. Domestic animals such as cattle, sheep, and goats, as well as several wild and small animals (rats, rabbits, certain birds), are carriers of this virus.

### **Symptoms**

The mortality rate is 10–40%.

- Initial Symptoms: Fever, muscle ache, dizziness, neck pain, stiffness in the neck, headache, backache, redness of the eyes, and sensitivity to light (photophobia). Nausea and diarrhea may also occur.
- Progressive Symptoms: Bleeding from hair follicles, increased heart rate, enlargement of lymph nodes, and bleeding under the skin (petechiae/ecchymosis). Blood may also be seen in stool and urine. Bleeding can occur from the nose and gums as well.

**Note on Animals:** Animals usually do not show any symptoms. They may experience a mild fever.

## Diagnosis

The disease can be diagnosed through blood tests. A PCR test is the best method for diagnosis.

## Treatment

Blood components must be administered in a timely manner to replace the blood lost due to hemorrhaging. The drug "**Ribavirin**" has been found to be useful. Plasma injections (convalescent plasma therapy) taken from recovered individuals are also sometimes administered.

## Prevention and Control

Care should be taken to prevent "ticks" from attaching to our bodies. Insect repellent lotions should be used if necessary. Those who tend to cattle and other livestock must take appropriate precautions (gloves, protective clothing, lotions). Parasite control in animals is highly important. Healthcare workers must follow **barrier nursing & universal standard precautions**.

## Chandipura Virus Disease

Chandipura Virus (CHPV) disease is an encephalitic illness (brain fever) caused by a virus that primarily affects children. This disease has been reported in Indian states such as Maharashtra, Gujarat, Andhra Pradesh, and Odisha. Apart from India, the presence of this virus has been identified in Bhutan, Nepal, Sri Lanka, and certain African regions.

The disease is transmitted by certain insects found in the soil, specifically **sandflies** (*Phlebotomus*). The infection spreads through insect bites. The disease is mostly observed in children in rural areas who play in the soil or mud.

## Symptoms

Symptoms include those typical of standard encephalitis, such as fever, headache, fatigue, vomiting, neck pain, and convulsions/seizures. Some individuals may develop breathing difficulties and pneumonia. The mortality rate among children is very high (**55–75%**).

## Transmission & Vectors

Although animals are suspected to be carriers of this virus, it is not entirely clear which specific animals are involved. However, studies have detected antibodies indicating the presence of the virus in pigs, cattle, goats, sheep, rats, and frogs. These animals may act as amplification hosts.

In insects of the *Phlebotomus* genus, the pathogen is found to persist continuously (making them permanent vectors) through transovarian transmission. The disease does not spread from human to human. No specific treatment or vaccine is available today. Controlling and eliminating sandflies is the primary method of prevention. The risk of disease transmission is higher during the post-rainy season.

As an emerging disease, more detailed information is still required regarding Chandipura virus disease. Since antibodies against this virus have been detected in studies across various other parts of India, the disease must be monitored with strict vigilance.

## Bacterial Diseases

## **Anthrax**

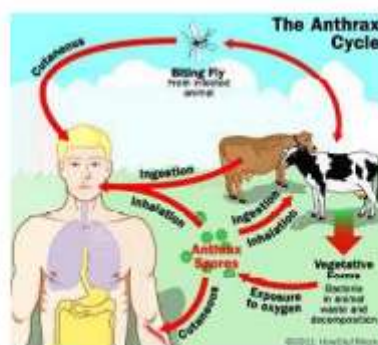
Anthrax is a bacterial disease that primarily affects warm-blooded animals. It is also known by other names such as *Kettuvaika* (കെട്ടുവൈക), *Wool-sorters' disease*, *Splenic fever*, and *Gilt-beerd*. Humans can contract the causative bacteria through direct contact with infected animals or from animal products. In our country, this is a disease commonly seen in various regions, particularly during the summer season.

## Causative Agent and Transmission

This bacterial pathogen enters the soil through the body fluids of infected cattle. When it comes into contact with open air, it transforms into microscopic particles called **spores**. These spores are highly resistant to all weather conditions and destruction. Consequently, these soil-bound spores can remain infectious in the ground for decades.

The spores enter the bodies of animals through deep grazing on parched pastures or through wounds and abrasions on the skin. During the summer, when cattle graze close to the ground on short grass, the spores easily enter their bodies along with the soil. Once inside the body, the spores germinate and rapidly multiply into pathogenic bacteria. The anthrax pathogen produces three types of dangerous toxins. These toxins ultimately lead to acute illness and death.

Humans contract this disease mainly through the carcasses or hides of animals that have died of anthrax. Usually, it is most found in individuals who handle hides/leather, butchers, those who process animal hair, and veterinary workers. When handling hides or meat in this manner, the bacteria can enter through abrasions on the hands or skin, by inhaling the spores into the respiratory tract, or by consuming the meat of infected animals that have died, thereby causing the infection.



## Symptoms in Animals

Generally, once an animal is infected, symptoms begin to appear within two to three days.

1. The disease often starts with a very sudden onset of fever. Body temperature can be seen rising up to 104°F to 108°F.

2. Refusal to take feed (loss of appetite) and abdominal distension/bloat.
3. In some cattle, swelling (edema) is visible in the throat area. The swelling can also spread to the jaw, brisket (chest area), and abdomen. Symptoms like breathing difficulties and breathing through the mouth can also be observed.
4. Excitable behavior may be seen at the beginning, followed later by dullness/lethargy.
5. If medicines are not administered, death can occur within two to three days, accompanied by shivering/tremors.
6. A characteristic feature of Anthrax is bleeding from all natural body orifices after death.
7. In pigs, swelling in the neck and face region, along with inflammation of the lymph nodes, is visible.
8. Sometimes, ulcers/lesions can be seen on parts like the lips, tongue, and hooves.
9. Often, animals are observed to collapse and die suddenly without showing any external symptoms beforehand.

### **In Humans**

Three types of clinical forms/symptoms are observed in humans.

1. **Respiratory Form:** The disease begins when anthrax spores enter the lungs through the air. People associated with the leather/tanning industry have a higher risk of contracting this form of the infection. It presents with symptoms like a persistent cold lasting for days, breathing difficulties, and shock. If left untreated in this condition, the mortality rate is close to 100%.
2. **Cutaneous Form:** The pathogen enters the body through wounds or cuts on the skin. It starts as a painless red lesion on the skin, which turns into a blister within one to two days, and subsequently transforms into an ulcer with a black center (eschar). It can then spread internally into the body and even cause death. The mortality rate is around 20%.
3. **Intestinal Form:** The pathogen, entering internally through the mouth, can affect the intestines, throat, or neck. Severe diarrhea, blood in the stool, and vomiting are common symptoms. The mortality rate ranges from 25% to 60%.

### **Diagnosis**



Anthrax can be diagnosed by observing the characteristic symptoms in affected animals. Under no circumstances should a post-mortem examination (autopsy) be conducted on animals suspected of having died from this disease.

If a microscopic examination is conducted on the blood of an animal that died soon after contracting the disease, the anthrax bacteria can be identified. Blood samples can be prepared on a slide from the ear vein of the carcass. By utilizing specialized microscopic stains, the unique capsule-bearing bacteria of anthrax can be clearly seen.

Furthermore, anthrax can also be diagnosed using modern diagnostic methods like PCR tests and ELISA tests by conducting cultural examinations.

### **Treatment**

If treatment can be initiated at the very beginning of the anthrax infection, the animal's life can be saved. This bacterium can be destroyed by administering antibiotics like penicillin and oxytetracycline in high doses. The treatment must be continued for up to 5 days.

### **Disposal of Carcass and Disease Prevention**

Proper disposal of the carcass is the best way to prevent the spread of the disease. It must be ensured that no blood or other bodily fluids from the dead animal spill onto the ground. The surroundings of such animals must be scientifically disinfected. All tools and items that meet the animal must be subjected to disinfection procedures. Formalin (10% solution), Sodium hypochlorite (10% solution), and Mercuric chloride (1% solution) are suitable chemicals used to destroy the spores. The carcasses should either be completely incinerated or buried deep in the ground at a depth of 8 feet. Lime and salt must be spread inside the pit dug for burial.

A radius of 20 to 30 kilometers around the disease-affected area must be declared as a disease-infected zone. The transportation of animals from these areas must be banned. A ban must be maintained for up to 50 days after the last anthrax case is reported from the locality. Vaccines must be administered to other animals in high-risk zones.

### **Vaccination and Related Preventive Measures**

- Vaccines that can be administered to animals are currently available.
- The Institute of Animal Health and Veterinary Biologicals (IAH&VB) in Palode, operating under the State Animal Husbandry Department, produces and distributes the spore vaccine against Anthrax.
- In areas where the disease is reported, animals must be vaccinated annually for five consecutive years.
- This vaccine should also be administered to domestic animals in areas that may come into contact with wild animals.

### Vaccination in Animals

| Category                                       | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name of Vaccine                                | Anthrax (Spore) Vaccine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Packaging - Vials                              | 100 ml vial (100 doses)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Dosage and Method of Administration            | <ul style="list-style-type: none"> <li>* <b>Cattle:</b> 1 ml subcutaneously in the neck.</li> <li>* <b>Sheep:</b> 0.2 ml subcutaneously in the inner thigh.</li> <li>* <b>Goat:</b> 0.5 ml subcutaneously in the neck.</li> <li>* <b>Horse:</b> 1 ml subcutaneously in the mid-neck.</li> <li>* <b>Elephant:</b> Subcutaneously in the fold of the ear.</li> <li>* <b>Elephant Dosage by Age:</b></li> <li>* Above 20 years: 3.0 ml</li> <li>* 15 – 20 years: 2.5 ml</li> <li>* 10 – 15 years: 2.0 ml</li> <li>* 5 – 10 years: 1.5 ml</li> <li>* 2 – 5 years: 1.0 ml</li> </ul> |
| First Vaccination and Subsequent Booster Doses | First dose at six months of age. In areas where the disease is regularly reported, vaccination must be given every year.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Immunity Period                                | One year                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

### Brucellosis

Brucellosis is a highly contagious disease capable of affecting humans and domestic animals. It is known by various names such as Mediterranean fever, Malta fever, Bang's disease, undulant fever, and goat fever. Consuming unpasteurized milk, milk products, and improperly cooked meat from infected animals, as well as maintaining close contact with infected animals, causes the disease to spread to humans.

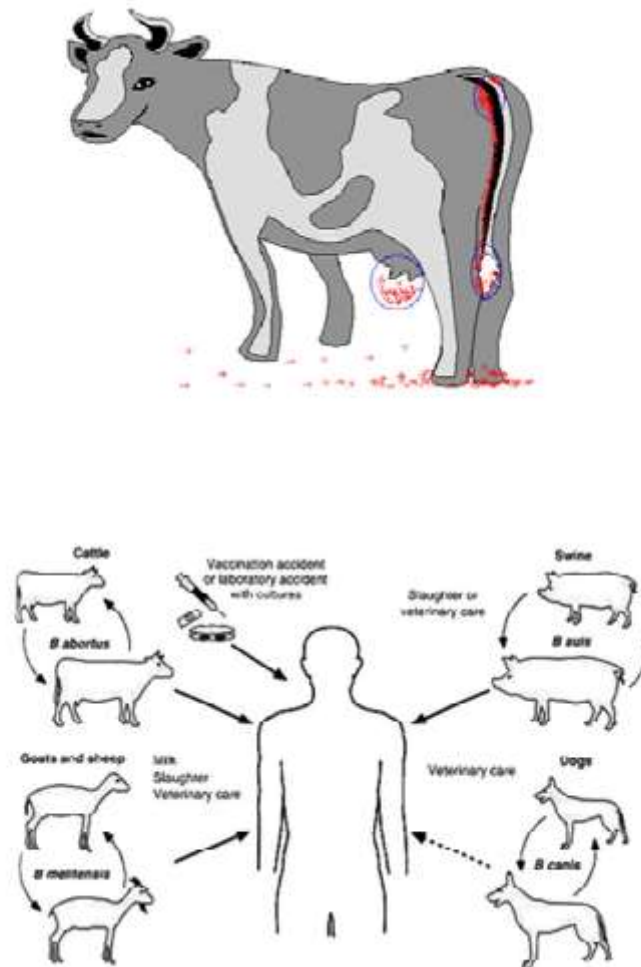
#### Causative Agent (Etiology)

Different species of bacteria belonging to the *Brucella* genus are the causative agents of this disease. *Brucella abortus* is the primary pathogen that causes the disease in cattle. *Brucella melitensis* in goats, *Brucella suis* in pigs, and *Brucella canis* in dogs are the primary causes of infection in those respective animals.

Although the mortality rate among cattle infected with Brucellosis is low, the resulting infertility and reduction in milk production cause severe financial losses to farmers and the dairy sector. The disease primarily affects the reproductive system and joints of cattle.

## Mode of Transmission

There is a high risk of humans contracting this disease by consuming unpasteurized milk or uncooked meat from infected animals, or by maintaining close contact with their bodily secretions. Since the pathogens are present in the milk of infected animals, consuming milk that has not been thoroughly boiled or pasteurized allows the pathogens to enter the human body. Humans can also contract the infection through respiration and by maintaining close contact with an infected animal. The pathogens can enter the human body through small cuts on the skin as well as through mucous membranes (especially those inside the eyes).



## Those at Higher Risk of Infection

Dairy farmers who have close contact with animals, veterinary officials, slaughterhouse workers, laboratory staff, and butchers face a higher risk of contracting this infection.

## Symptoms in Animals

- In infected cattle, the main symptoms are abortion during pregnancy, infertility, and low milk yield.
- In the early stages of the disease, the pathogens are found in the lymph nodes of the animals.

- In adult animals, the pathogens are mostly found in the reproductive organs (uterus).
- This causes abortion in pregnant cattle, typically occurring during the last three months of pregnancy, and leads to infertility and a reduction in the birth rate of calves.
- Swelling in the joints, which leads to lameness, is another major symptom, particularly observed in bulls.

### **Symptoms in Humans**

- Symptoms include an intermittent fever (which rises and falls regularly), fatigue, chills, severe headache, body aches, and joint pain.
- Body aches and weakness are the primary symptoms of this disease in humans.
- If the infection becomes chronic, depression and mental anxiety can occur.
- In the acute stage of the disease, symptoms such as persistent fever, weakness, and pain in various parts of the body and joints become prominent.
- Since proper treatment is often delayed, the pathogens may permanently reside in the body, which can lead to life-threatening complications.
- In pregnant women, abortion is a major symptom of this disease.

### **Diagnosis**

- Diagnosis can be carried out by testing the milk, blood, and aborted foetuses of suspected animals.
- Changes in the blood cell count, chills, etc., can be identified through a blood test.
- The presence of the pathogens can also be detected in the blood, milk, semen, vaginal discharges, and amniotic fluid fluids of infected animals.

### **Tests**

Rose Bengal Plate Test (RBPT), ELISA, and PCR are the tests commonly conducted for diagnosis.

### **Treatment**

- Treatment is not practical in animals, and its ability to spread to humans makes this disease highly dangerous. For this reason, treatment methods are not adopted in animals.
- Cattle that do not show symptoms can act as dangerous carriers and transmit the disease to both humans and other animals. If a diagnosis is confirmed through testing, it is best to cull/remove them immediately.
- Effective treatment is available for humans. This requires antibiotic therapy lasting for several weeks.

### **Preventive Measures**

- People who have no direct contact with animals contract the disease primarily by consuming unboiled milk, unpasteurized dairy products, etc.

- Eradicating the disease from an area is only possible by completely isolating or removing infected animals.
- The disease can be completely prevented in cattle by vaccinating female calves between four to eight months of age. A single vaccination in their lifetime is sufficient. As part of the Central Government's disease control program, the Animal Husbandry Department is conducting vaccinations. The S19 live vaccine is used for this purpose.
- It is absolutely essential to periodically inspect farms and other facilities to check for the presence of the disease.
- In situations where complete eradication of the disease is not possible, the following steps can be adopted: Maintain complete cleanliness and sanitization in cattle sheds. Scientifically dispose of and bury the placenta, vaginal discharges, and aborted fetuses.
- Pasteurize milk and dairy products. Avoid unpasteurized milk and milk products and avoid eating meat that is not properly cooked.
- Those working in farms, slaughterhouses, etc., must enter only after wearing adequate personal protective equipment (PPE). This helps prevent various animal secretions from staining or meeting the body.
- Joint efforts from those working in the public health sector and the animal husbandry sector are essential for this.
- Since there is a possibility of contracting the infection from the live vaccine itself, animal husbandry staff participating in the vaccination drive must adopt necessary safety gear and precautionary guidelines.

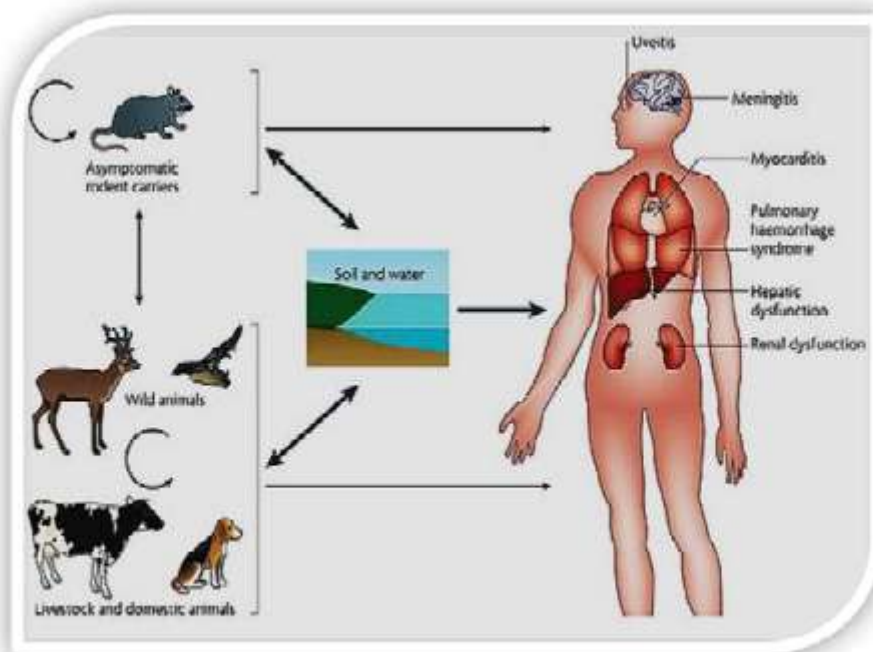
### **Leptospirosis**

Leptospirosis, commonly known as "Elippani" (rat fever), is a major bacterial disease found in both humans and animals. This disease is prevalent in all parts of the world. It is caused by bacteria belonging to the *Leptospira* genus. There are more than 200 different variants (serovars) capable of causing this disease. Among domestic animals, it affects dogs, cattle, goats, sheep, pigs, and horses. This disease is rare in cats. Birds are generally not affected by this disease.

#### **How is the disease transmitted?**

Members of the rodent family are silent carriers of Leptospirosis. They carry the bacteria in their bodies, particularly in the kidneys, usually without becoming ill themselves. The disease is primarily transmitted through the urine of these carriers; this is why the disease earned the name "Elippani" (rat fever).

Infection occurs when the urine of rodents contaminates drinking water or food or enters the body of humans or animals through skin wounds, soft skin, or mucous membranes. Besides rodents, the disease can also be spread through the urine and genital secretions of infected or recovered domestic and wild animals. Under favorable conditions, these pathogens can remain virulent in soil and other environments for several months.



### Those at Higher Risk of Contracting the Disease

- Farmers working in fields and plantations
- Veterinary doctors
- People who maintain close contact and interact with animals
- Slaughterhouse workers
- Milkers / Dairy handlers
- Sanitation workers
- People who bathe in ponds
- People who handle pathogens in laboratories

### Symptoms of the Disease

Once the pathogens enter the body, the severity of the disease will vary depending on the immunity of the human or animal. It is not necessary for 100% of infected individuals or animals to display these symptoms.

#### In Humans

The onset of the disease usually begins with a high fever. Severe headache, muscle pain, redness of the mucous membranes in the eyes, and sometimes bleeding through the nose may also be observed. If proper treatment is not made available at the onset of the illness, the disease can be fatal.

#### In Animals

In domestic animals such as cows, buffaloes, goats, and sheep, symptoms may appear within 2 to 7 days of contracting the infection. High fever (104°F to 105°F), redness of mucous

membranes, loss of appetite, and abortion (abortion is commonly seen in animals that are more than six months pregnant) followed by retention of the placenta are common. The disease severely affects productivity. Excretions via the retained placenta and genital tract spread the leptospirosis bacteria to others.

Mastitis (inflammation of the udder) is also observed in infected milch animals. Due to this, the color of the milk may appear tinged with a light red hue. Sometimes, in mastitis, all four quarters of the udder may swell up without severe pain, resulting only in a change in the color of the milk. A sudden drop in milk yield without any other apparent illness can be a reason to suspect a leptospirosis infection.

Even after recovering from the illness, the animals continue to shed the bacteria through their urine for 2 to 3 months, which poses a threat to other animals and humans.

### **Goat, Sheep**

The severity seen in cattle is usually not observed in these animals. Loss of appetite, fever, abortion in the late stages of pregnancy, and retention of the placenta are the main symptoms. Recovered animals can continue to excrete the pathogens through their urine for up to two to three months.

### **Dogs**

High fever (104°F to 105°F), refusal of food, vomiting, jaundice, and sometimes bloody urine are the primary symptoms of the disease. Recovered dogs can continue to excrete the pathogens for 6 to 9 months.

### **Diagnosis**

Diagnosis can be conducted by testing the blood and urine at various stages of the disease. The leptospirosis bacteria are found in the blood during the initial stage of the illness, and in the urine during the recovery phase. Diagnosis can also be performed by measuring the immunity (antibodies) developed against these bacteria.

### **Treatment**

If the diagnosis is made early, treatment is highly effective. Antibiotics ranging from penicillin, discovered decades ago, to doxycycline, discovered in recent times, are capable of destroying these bacteria. If domestic animals show symptoms of the disease, special care must be taken to treat them under the supervision of a veterinary doctor.

### **Preventive Measures**

Priority must be given to preventive vaccinations for animals, rodent control (rat eradication), and methods to prevent the disease from spreading.

In our country, preventive vaccination for this disease is currently available only for dogs. For puppies, the first vaccination should be given at two months of age, followed by a booster dose in the third month, and thereafter, annual revaccinations must be carried out. A limitation is that since there are various leptospirosis strains (>200), it is not possible to include all of them in the vaccines. The vaccines generally contain 2 to 4 strains that commonly affect dogs.

Situations where these bacteria can come into contact with the skin of humans and animals must be avoided. The next best step is to ensure that they do not reach drinking water and food. The main approach in this is rodent control.

- Rats can be destroyed using various types of rat traps and other methods.
- Environments that allow rats to grow and multiply must be eliminated. Waste management is the most important factor in this.

### **Other Preventive Measures**

If an abortion occurs in domestic animals, the aborted fetus, placenta, and waste from the reproductive tract can be carriers of leptospirosis. They must be buried deep in the ground after mixing with lime or other disinfectants. As far as possible, this should be done far away from water sources. These materials must be handled only by using gloves. If the urine of animals stains or comes into contact with our body parts the urine must be washed immediately with soap and cleaned using any disinfectant. If an animal has mastitis, its milk must not be used under any circumstances. If such milk falls on the hands or other body parts, they must be washed with a disinfectant like Dettol.

Provide only clean water for domestic animals to drink. Under no circumstances should they be allowed to drink stagnant water from fields, plantations, etc. Humans and animals should avoid bathing in the same water bodies.

Special precautions must be taken during times when the likelihood of contracting the disease is higher, such as the rainy season and floods. If necessary, depending on the situation, preventive antibiotics can be used under the supervision of a doctor.

Those engaged in occupations with a higher risk of contracting the disease (High Risk Group) must make it a habit to use protective gear.

### **Tuberculosis**



### **Zoonotic Tuberculosis**

Tuberculosis in humans caused by the tuberculosis pathogens found in animals is called Zoonotic Tuberculosis. The most important of these is the disease caused by the pathogen *Mycobacterium bovis* (*M. bovis*) found in cattle. This is also known as Bovine Tuberculosis.

## Bovine Tuberculosis



It is estimated that approximately 5% to 10% of tuberculosis cases occurring in humans are caused by *M. bovis*. *M. bovis* is often considered to be the cause of extra-pulmonary tuberculosis in humans. Tuberculosis that occurs in places other than the lungs is called extra-pulmonary tuberculosis. Abdominal Tuberculosis, which occurs in the abdomen, belongs to this category.

The fact that *M. bovis* is resistant to Pyrazinamide, a first-line treatment drug for tuberculosis, often creates a crisis in treatment. Another major challenge is that standard diagnostic methods are not capable of differentiating between these two types of tuberculosis.

Cattle are the primary hosts of *M. bovis*. Wild animals such as gaur (bison) and deer also exist as sources for these. Many countries, including India, are endemic areas for bovine tuberculosis.

## Tuberculosis – Causative Agents



Pathogens belonging to the *Mycobacterium* genus are the cause of tuberculosis. Although they can cross-infect, different species are predominantly found in specific categories of living beings:

- In Humans: *Mycobacterium tuberculosis* (*M. tuberculosis*)
- In Animals: *Mycobacterium bovis* (*M. bovis*)

- In Birds: *Mycobacterium avium* (*M. avium*)

### **Who Can Be Affected by Tuberculosis**

The disease can affect humans as well as approximately 170 species of birds and animals. Among domestic animals, it is seen in cattle, goats, sheep, pigs, horses, and cats. It is also found in wild animals like elephants, bears, and deer, as well as in birds. This disease can even affect amphibians and aquatic life.

### **Disease Transmission:**

Since it is a disease that primarily affects the lungs, it is transmitted through the air and close contact, as well as through items contaminated with phlegm, nasal secretions, animal excretions, and urine.

The disease is primarily transmitted from animals to humans through the consumption of unboiled milk and by spending a significant amount of time in close contact with infected animals. There is also a high possibility of contracting the infection among laboratory workers.

The disease can spread among animals through grazing in contaminated pastures. In crowded farms, the disease spreads rapidly. Transmission can also occur through air-conditioned, tightly enclosed milk sheds and barns. Infected cattle can remain carriers for many years without showing any external symptoms. Through this, there is a high likelihood of the disease spreading to other cattle in the herd.

### **Symptoms of the Disease in Animals:**

The prominent symptoms include weakness, progressive emaciation of the body, difficulty breathing, respiratory complications, swelling of the lymph nodes, chronic coughing, intermittent diarrhea, intermittent fever, persistent mastitis, and a drastic reduction in milk yield. The body gradually wastes away, eventually leading to death over a period of years. Just like in humans, there is also a latent state (Latent TB) where the disease progresses without showing any apparent symptoms.

### **Symptoms of the Disease in Humans:**

Commonly observed symptoms in humans include fever, fatigue, night sweats, loss of appetite, weight loss, chest pain, coughing, coughing up blood or phlegm when coughing, and severe weakness. Apart from the lungs, TB can also occur in other parts of the body such as the eyes, skin, bones, joints, brain, and abdomen.

### **Diagnosis**

#### **In Animals:**

Unlike other diseases, because it does not exhibit specific symptoms, identifying this disease in the beginning stages is difficult. Diagnosis can be conducted through an intradermal injection method called the Tuberculin Skin Test. Along with this, the illness can also be detected through tests like bacterial culture, PCR, histopathology, and ELISA. Tests are often not effective in the early stages of the disease. Tuberculosis diagnosis is an area wrapped in many challenges.



**Caption under images: Tuberculin test conducted by injecting inside the skin**



### **Diagnosis in Humans:**

A comprehensive medical evaluation includes a history of the disease, clinical examination, smear microscopy, chest X-ray, laboratory examination, culture, and an intradermal tuberculin injection test (Mantoux Test). Modern methods like PCR are effectively utilized today.

A complex factor in tuberculosis diagnosis is that culturing the tuberculosis pathogen (growing the bacteria in a laboratory for testing) is difficult. This is due to the slow growth rate of the tuberculosis bacteria. It takes about 4 to 12 weeks to subject phlegm or blood to this test. This examination can only be conducted in laboratories with specialized safety setups.

### **Treatment Methods in Animals:**

Treatment methods are not adopted in animals. Treatment is neither practical, effective, nor economical. The fact that it can spread to humans makes tuberculosis in cattle highly dangerous.

Once a diagnosis is confirmed through testing, the animals are removed immediately. There are currently no vaccines available for animals. Trials are ongoing to determine if the BCG vaccine will be effective for calves.

### **Treatment in Humans**

Treatment with specific antibiotics lasts for a duration of 6 to 12 months.

### **Zoonotic TB: Prevention and Control**

Tuberculosis can spread to animals that maintain close contact with infected humans (Reverse Zoonosis). This mode of transmission has been observed in elephants and bears in circus tents. The primary requirement is to prevent the transmission of infection from animals to humans and vice versa. A comprehensive One Health approach would be a significant milestone, and a multi-pronged approach is necessary:

- Infected animals must be isolated or removed.
- It must be ensured that animals brought from other states are free of tuberculosis.
- Cattle sheds, surroundings, and feed/water troughs must be kept clean using disinfectants.
- If tuberculosis is suspected in a dead animal, the advice of a veterinary doctor must be sought.
- New animals must be quarantined for 60 days and subjected to TB testing before they are allowed to interact with other livestock (Test and Slaughter method).
- Conduct intensive monitoring in agricultural areas and systematic individual inspections of livestock to identify and remove animals that are infected or have been in contact with the disease.
- Avoid proximity to wild animals, their excreta, and other secretions. Prevent the entry of wild animals into water bodies and pastures where domestic animals roam.
- Infected elephants and other domestic animals should not be used for festivals, exhibitions, or fairs.
- Ensure adequate regional legislation. Implement regulations for moving animals from one location to another and ensure methods for animal identification.
- The disease can be detected and its spread prevented through the scientific handling and monitoring of meat in slaughterhouses (Post-mortem and Ante-mortem inspection).
- Take care to use only pasteurized dairy products and consume only well-cooked meat.
- Since milkers, slaughterhouse workers, and veterinary doctors have a higher risk of contracting tuberculosis daily, necessary precautions must be taken.
- Well-trained personnel in public health are necessary for the eradication of tuberculosis.

### **Escherichia coli (Escherichia coli) Infection**

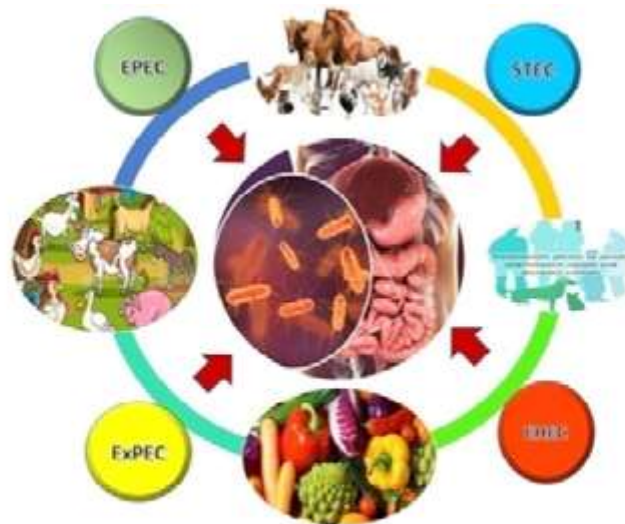
#### **(E. coli Disease)**

*Escherichia coli* (*E. coli*) is a bacterium normally associated with foodborne illnesses. It is a bacterium commonly found in the intestines of humans and warm-blooded animals. Not all *E. coli* variants (strains) are harmful; however, some can cause diseases.

This pathogen can cause severe abdominal pain, bloody diarrhea, and can even progress to severe complications ranging from dehydration to kidney failure. Pathogens in the bloodstream cause a wide variety of infections, including urinary tract infections (UTIs), meningitis, and septicemia in both humans and animals. It is noteworthy that the pathogen is widespread in the reproductive tracts of animals, and in birds, colibacillosis caused by *E. coli* leads to heavy financial losses in the poultry industry.

#### **Causes and Modes of Transmission**

The disease can be contracted primarily by consuming contaminated foods such as raw or undercooked meat products, unpasteurized milk, and raw vegetables, or through close contact with infected animals or their surroundings. The disease is primarily transmitted through the fecal-oral route.



### Symptoms of the Disease:

- In Animals Symptoms such as diarrhea, dehydration, and a reduction in milk yield may be exhibited. In birds, the infection causes disease by first affecting the lungs and subsequently spreading to other organs. This can also develop into septicemia. In cattle, it acts as a causative agent in urinary tract infections and mastitis, causing a significant drop in milk production and resulting in heavy financial losses. Sometimes, it can even lead to the death of cows. E. coli infection of the urinary tract is also a major cause of death in pigs. Other domestic animals (dogs, cats, and goats) can also contract infections due to E. coli.
- In Humans Symptoms include abdominal pain, diarrhea (often bloody stools), vomiting, and sometimes a low-grade fever. In severe cases, especially in children, the infection can become critical.

### Diagnosis:

To diagnose E. coli infections, laboratory testing of samples can be conducted to identify the presence of the bacteria and the specific toxins they release.

### Treatment:

In severe or prolonged cases, medical intervention may be necessary to manage symptoms and prevent complications like dehydration. In animals, antimicrobial therapy must be started immediately for treatment. Balanced electrolyte solutions should also be administered.

### Prevention and Control:

- Food Safety Practices: To prevent E. coli infection, food safety practices must be ensured, including cooking meat thoroughly, preparing and storing food safely, and ensuring the safety of raw milk and dairy products.

- **Personal Hygiene:** Maintain personal hygiene by washing hands thoroughly with soap before preparing, serving, or eating food, as well as after handling domestic animal feces or visiting a farm.

### **Salmonellosis (Salmonellosis)**

Salmonellosis is a bacterial infection that affects the intestines of both humans and animals. It is estimated that 99% of *Salmonella* infections are caused by *S. enterica*.



### **Disease Transmission**

- Infection typically occurs through the mouth, leading to diarrhea.
- Infection can be caused by the feces, feed, water, and milk of infected animals, as well as meat from slaughterhouses.
- Plants used as fertilizer or feed, animal products, pastures, and various inert objects can also spread the infection.
- Rats and wild birds are sources of infection for domestic animals.

### **How does Salmonellosis in animals spread to humans?**

- Food products derived from animals are considered the primary source of human infection.
- The most common sources of infection are eggs and related products, meat, milk, and dairy products.
- Washing fruits and vegetables in contaminated water can also cause infection.
- Healthy-looking dogs and cats living in the same house can be carriers of *Salmonella*.
- Humans are at risk of contracting the disease whenever they handle food contaminated by these carriers.

### **Symptoms in Animals**

- Normally, infected animals carry the pathogen and spread it to others without showing any symptoms themselves. These are called carriers.
- Symptoms such as swelling (inflammation) and blood poisoning (Septicemia) may occur.
- Abortion can occur in pregnant animals.

## **Symptoms in Humans**

- Symptoms such as dysentery, fever, vomiting, diarrhea, and severe abdominal pain appear within 24–72 hours after infection.
- In rare cases, diarrhea can lead to severe dehydration, requiring urgent medical intervention.
- If the infection spreads to the intestines, it can even become life-threatening.

## **Diagnosis**

A diagnosis of Salmonellosis can be established based on clinical symptoms and by isolating the bacteria through cultural examination or via serological testing based on the presence of symptoms. Serological tests are available to identify antibodies in blood or milk, and these are widely used in Salmonellosis surveillance and control programs.

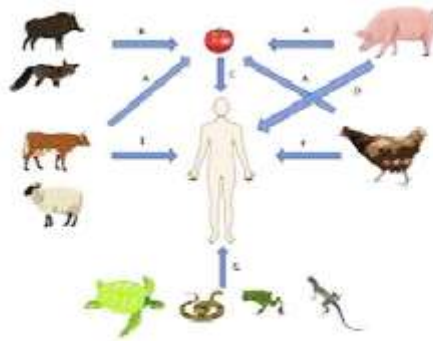
## **Treatment**

- Antibiotics and other supportive medicines must be administered to infected animals.
- Antibiotics are generally not given to carrier animals (those with asymptomatic infections); it is best to avoid them.

## **Prevention and Control**

Contaminated feed and surroundings are the primary sources of transmission for Salmonellosis. Programs have been implemented by the government to control and eradicate the presence of infection in poultry farms.

1. Infected animals/birds must be identified and isolated or removed immediately.
2. Proper treatment is essential for animals displaying symptoms of the disease.
3. Strict biosecurity protocols must be implemented.
4. To control the spread of infection, vector control measures must be adopted in farms.
5. Care must be taken to ensure that the feed and water provided to animals are clean and free from contamination.
6. Vaccines are highly effective, and some are commercially available.
7. Farmers must be made well-aware of the dangers of interacting with infected animals and the paramount importance of personal hygiene.
8. Transmission to humans via food (foodborne transmission) must be prevented through stringent food safety measures.



## Listeriosis



### Disease Description:

Listeriosis is an infectious disease caused by the bacterium *Listeria monocytogenes*.



### Causative Agent (Etiology):

The causative agent is the bacterium *Listeria monocytogenes*. This bacterium typically has the ability to survive refrigeration processes and multiply many times over in number. In immunocompromised individuals, it is observed either as a systemic infection affecting the whole body or as an inflammation of the meninges in the brain (meningitis). In animals, when it affects the brain, "Circling" behavior is a characteristic visible symptom unique to Listeriosis.

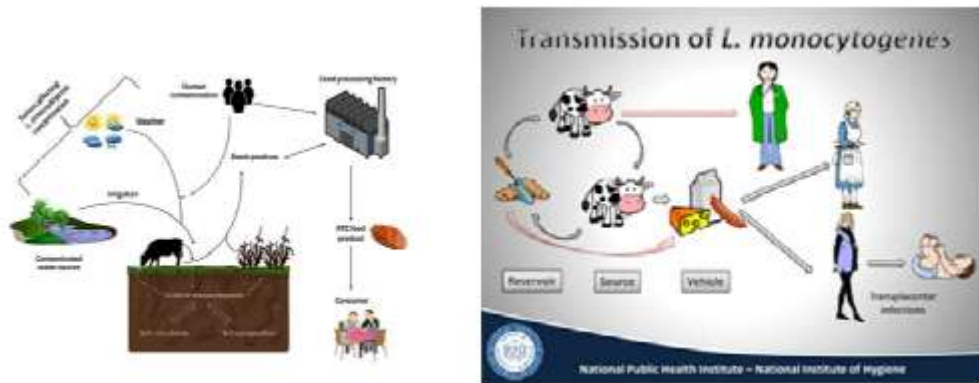
**Animals affected by the disease:** Ruminant animals (goats, cattle). It also affects other living beings such as rabbits, guinea pigs, dogs, cats, pigs, poultry, canaries, and parrots.

### Disease Transmission:

The natural habitat of this bacterium is soil and the digestive tract of mammals. The pathogens that reach the external environment through excreta are found on vegetation. Grazing animals ingest the bacteria along with green leaves; in a cyclical manner, they contaminate the plants

and soil again through their dung. The transmission from one animal to another occurs when particles of excreta enter through the mouth.

In humans, *Listeria* infection is usually contracted through food. The pathogens can be present in unboiled milk and undercooked meat. Furthermore, the placenta and fetus are sources of the *Listeria* bacteria. Direct transmission from all of these sources is possible through close contact.



### External Symptoms in Animals:

- Infected animals may experience fever and a loss of appetite.
- In some animals, facial muscles can become paralyzed.
- In certain instances, an infected animal will walk in a circle with its neck twisted to one side, or it may press its head against a hard, solid surface.
- Continuous salivation from the mouth and food materials getting packed or pocketed inside the cheeks are also symptoms of the disease.
- As the disease advances to an acute stage, animals collapse to the ground, lie tilted on one side, and become unable to rise.
- While lying down in this position, the animals often exhibit running or paddling movements with their legs.

### Reproductive Impacts:

- Abortion caused by *Listeria* typically occurs during the final three months of pregnancy.
- The expulsion of fully developed fetuses that are stillborn, as well as neonatal calf mortality, can occur due to a *Listeria* infection.

### Symptoms in Humans:

- Clinical symptoms associated with Listeriosis include fever, gastroenteritis, meningitis, meningoencephalitis, and infections linked to pregnancy.
- These pregnancy-linked infections include spontaneous abortion, premature birth before completing full term, and neonatal diseases.
- Listeriosis infection carries a mortality rate of approximately 20%.

## Diagnosis

### In Animals:

- Brain dysfunction can lead to a suspicion of a *Listeria* infection.
- A *Listeria* infection can be confirmed by conducting a bacterial culture on samples obtained from dead animals, aborted fetuses, milk, or meat.

### In Humans:

- An initial diagnosis of Listeriosis is made based on clinical symptoms and by detecting the bacteria in samples taken from blood, cerebrospinal fluid (CSF), neonatal meconium (or the fetus in cases where abortion occurs), feces, vomitus, or food.
- Diagnostic methods such as Polymerase Chain Reaction (PCR), cultures of blood and placenta, biochemical confirmation from food samples using test strips, Enzyme Immunoassay (EIA), and ELISA have all been specifically developed and utilized for *Listeria*.

## Treatment

- **Humans:** Listeriosis is treated using high doses of antibiotics once a diagnosis is confirmed.
- **Animals:** Infected animals should be isolated from others. Since it is difficult to conduct a diagnosis, antibiotic treatment should be provided immediately in suspected cases.
- To successfully deliver antibiotic drugs into the brain, high doses of medication are necessary. Fluids and electrolytes should also be provided as needed.

## Prevention and Control

1. Maintain thorough food safety.
2. Clean utensils properly.
3. Cook food thoroughly.
4. The elderly, immunocompromised individuals, and pregnant women should avoid raw meat, raw vegetables, unpasteurized or raw milk, and soft cheeses.
5. Provide cattle with high-quality silage (those with low acidity); do not feed them silage that is of poor quality. Avoid feeding them silage that is spoiled, moldy, or taken from the top layers of the silo that have been exposed to air.
6. Control rodents (rats).

## Campylobacteriosis (Campylobacteriosis)

Campylobacteriosis is an infection caused by the bacterium *Campylobacter*. This disease is most commonly caused by *Campylobacter jejuni* and *Campylobacter coli*. In humans, the infection is typically contracted through milk, meat (especially poultry), water contaminated with animal excreta, and close contact with animals.

**Causative Agent:**

*Campylobacter* is a genus of bacteria that live naturally as commensals in the intestines of many species of birds and mammals. *Campylobacter* is frequently found in the intestines of healthy poultry.



Figure .1: Campylobacter bacteria

**Disease Transmission:**

The infection is transmitted through food and water contaminated with animal excreta. The main reservoirs for *Campylobacter* bacteria are birds and mammals. Incompletely cooked meat, especially chicken, is a primary source of the bacteria.

Failing to maintain proper hygiene during slaughterhouse operations can be a cause of infection. Consuming raw milk, contaminated water, vegetables, and fruits can also lead to infection. Humans can contract the disease by making direct contact with the feces of infected animals.

**Symptoms of the Disease:**

Symptoms usually manifest within 2 to 5 days after the pathogen enters the body.



Figure 2: Transmission of Campylobacter

**Animals Affected by the Disease:**

*Campylobacter* infections can affect numerous animals, including birds, dogs, cats, calves, goats, pigs, monkeys, and laboratory animals. Migratory birds, waterfowl, crows, and domestic pigeons commonly carry *Campylobacter* bacteria naturally. They contaminate the environment of grazing animals.

It has been reported that pests like wild rodents and flies also harbor and spread these pathogens. Since domestic poultry is the most significant reservoir for *Campylobacter jejuni* bacteria, chicken meat becomes their main source. Dogs and cats can become infected when they consume undercooked chicken meat.

### **Prognosis and Mortality Rate:**

*Campylobacter* infections are generally not life-threatening. Death occurs only in very rare instances. Mortalities can happen in elderly individuals or those with compromised immune systems. However, even healthy individuals can succumb to the illness if severe dehydration occurs.

### **Symptoms of the Disease in Animals:**

- Infected animals typically do not show any symptoms, but they can shed the bacteria into their environment (carrier state).
- This disease can sometimes cause very severe diarrhea, especially in young animals.
- The most important symptoms are abdominal pain, fever, diarrhea, and blood in the stool.
- In cattle and goats, *Campylobacter* bacteria can cause inflammation of the small intestine and abortion.
- *Campylobacter* bacteria do not cause clinical disease in pigs.
- In poultry, this disease leads to liver problems and a significant reduction in egg production.

### **Symptoms of the Disease in Humans:**

- This disease only rarely becomes life-threatening.
- Like all food poisoning, the main symptoms of *Campylobacter* infection are abdominal pain, headache, fever, vomiting, and diarrhea.
- Inflammatory gastroenteritis causes blood in the stool and extreme abdominal pain.
- Additionally, it can affect other glands that aid digestion, such as the liver and pancreas.
- Chronic arthritis and neurological disorders can also occur in connection with *Campylobacter* infection.

### **Diagnosis:**

- A preliminary diagnosis can be made through clinical symptoms and post-mortem findings.
- Furthermore, a confirmed diagnosis can be conducted through PCR testing.

### **Treatment:**

- In animals, dehydration can be prevented by providing electrolytes as needed.
- Antimicrobial treatment is recommended.

- Cows affected by genital campylobacteriosis are usually not treated for practical reasons.
- Infected bulls are not used as breeding bulls or for semen collection.
- *Campylobacter jejuni*, which causes campylobacteriosis, is resistant to many antibiotics.
- The use of antibiotics may be able to prevent abortion in infected sheep.

### **Prevention and Control:**

- Prevention is based on control measures at all stages of the food chain, from production to the processing, manufacturing, and preparation of food items.
- Maintaining strict hygiene in slaughterhouses is the first step in preventing *Campylobacter*.
- Contamination can be reduced through hygienic slaughtering methods.
- Immunization (preventive measures) for birds in farms against diseases is legally mandated.
- Cook only after washing the meat thoroughly; avoid repeating the process of thawing and heating cooled meat as much as possible; wash hands before cooking; use only boiled milk and water.
- Wash hands after coming into contact with birds.

### **Prevention in Birds:**

- > Do not allow stagnant dirty water to accumulate.
- > Do not give uncooked meat.
- > Ensure cleanliness in cages.
- > Avoid contact with other birds and animals.
- > Do not use sick birds for breeding.
- > Isolate or eliminate those with symptoms of illness.

### **Clostridium Food Poisoning**

Food poisoning caused by Clostridium, specifically Clostridium perfringens and Clostridium botulinum, is highly significant.

#### **Clostridium perfringens**

Food poisoning caused by Clostridium perfringens is one of the most common causes of foodborne illness. These bacteria are normally found in soil, water, the atmosphere, and the feces of birds. This infection is commonly spread through contaminated food (meat, fish, vegetables).



Figure 1: Clostridium perfringens

**Causative Agent:-** Clostridium perfringens is a bacterium belonging to the genus Clostridium. This microorganism has the ability to form spores. They are capable of surviving both heat and cold.

Clostridium perfringens is found as a normal inhabitant in the intestines of humans and animals. However, this bacterium has the potential to cause disease through food items that are not properly cooked or packed. Because they produce spores, they are not completely destroyed by cooking.

**Spread of Disease:-** There is a high probability of finding Clostridium spores in cooked foods kept at ambient room temperature for a long time, as well as in meat that has not been cooked at the required temperature. Infection occurs by consuming meat contaminated with such spores. Symptoms manifest within 8 to 16 hours.

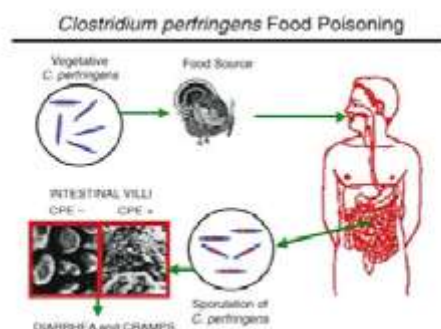


Figure 2: Clostridium perfringens Food Poisoning

**Symptoms:-** The symptoms manifest due to a toxic substance (toxin) produced by this bacterium. When a large number of bacteria enter the body, the bacteria that survive the intestinal acid grow in the intestine and release a toxin (enterotoxin) that causes diarrhea. The mortality rate is very high in animals.

**Symptoms in Humans:-** Clostridium food poisoning causes diarrhea. Nausea, vomiting, abdominal pain, and fever may also occur. It usually takes 8 to 12 hours for symptoms to appear, but this can extend up to 24 hours.

**Diagnostic Methods in Humans:-**

- Medical Examination- Diagnosis based on clinical symptoms
- Laboratory Tests
- Stool Test: Tests are mainly conducted using cultures of stool (faeces).
- Food Samples: Analysis of food samples is necessary if food poisoning is suspected.

**Diagnostic Methods in Animals:**

Symptoms, laboratory tests, PCR, and ELISA are used for diagnosis.

**Treatment in Animals:**

Due to the severity of the disease, treatment is usually not effective. However, if treatment is attempted, specific hyperimmune serum and antibiotics should be administered. To prevent dehydration caused by severe diarrhea in animals, fluids should be given intravenously as required.

**Treatment in Humans:**

Specific treatment is generally not required for the infection. Continuous diarrhea leads to the loss of water content and salts like sodium and potassium from the body. In severe cases, antibiotics may need to be taken under a doctor's guidance.

**Disease Prevention and Control – In Animals:**

- Enterotoxaemia in goat kids can be controlled by reducing the amount of carbohydrates in their feed.
- Provide a balanced diet, probiotics, etc.
- Avoid giving contaminated water and stale food items to animals.
- Treat all secondary diseases in a timely manner.
- Deworming treatment.
- There is a preventive vaccine for Enterotoxaemia in goats.

**Food Poisoning Control**

Food poisoning can be avoided by taking precautions while heating, storing, and serving food.

- Wash hands before and after preparing food.
- Thoroughly clean surfaces and utensils before and after preparing food.
- Cook food items only after washing them thoroughly in clean water.
- Cook food at a safe temperature (cook at a high temperature ranging from 145 degrees Fahrenheit to 165 degrees Fahrenheit, or from 62 degrees Celsius to 73 degrees Celsius).

- Store food below 4 degrees Celsius or above 60 degrees Celsius.
- Place meat, poultry, and seafood in the refrigerator or freeze them as quickly as possible.
- Prepared food should not be kept outside for more than two hours.
- Avoid eating food that has been kept outside for more than one hour without being reheated.

### Yersiniosis



Diseases caused by the bacteria *Yersinia enterocolitica* and *Yersinia pseudotuberculosis* are zoonotic diseases known worldwide. They are caused by contaminated food, water, and contact with animals. Among these, the bacteria usually reach humans through raw or undercooked pork products, unpasteurized milk, or milk products.

#### **Cause of the Disease:**

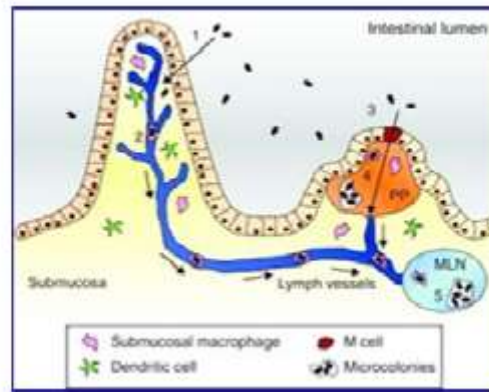
*Yersinia enterocolitica* is a bacterium belonging to the Enterobacteriaceae family. Although *Yersinia enterocolitica* is the cause of most such diseases in humans, *Yersinia pseudotuberculosis* also causes infections to a lesser extent.

#### **Animals Affected by the Disease:**

*Yersinia enterocolitica* has often been found in wild animals (e.g., wild boars) and domestic animals (e.g., sheep, cattle, goats, pigs, poultry). However, pigs are the most important source of infection in humans. The pathogenic *Yersinia enterocolitica* strains have been isolated from pigs. It is often seen that even after infected animals recover, they continue to remain carriers of the disease.

#### **Transmission of the Disease:**

This pathogen reaches its next host through contaminated food or water.



Four modes of transmission for *Yersinia enterocolitica* have been identified.

1. Transmission through food: *Yersinia enterocolitica* has been isolated from various food items including milk, beef, pork, fish, chocolate, and pasteurized milk. However, the disease is primarily transmitted through the consumption of raw or undercooked pork.



2. Transmission from human to human: Although it is very rare, cases of *Yersinia enterocolitica* spreading from person to person through diarrheal illness have been reported.
3. Transmission from animals to humans: This can happen either indirectly or directly. It has been reported that *Yersinia enterocolitica* spreads through contact with infected animals, especially pigs, and their feces.
4. Transmission through water: *Yersinia enterocolitica* can survive for a long time in cold water sources; therefore, contaminated water can act as an indirect source for the transmission of the bacteria.
5. Direct Transmission: Very rarely, the disease can be transmitted from a patient to another person using unsterilized injection needles.
6. Blood-borne Transmission: *Yersinia enterocolitica* is a disease that can be transmitted through blood donation.

**Disease Symptoms in Animals:**

Animals generally do not exhibit symptoms of the disease. In some cases, symptoms such as vomiting, diarrhea, and weakness may be shown. Weight loss has been observed in infected animals. Infection by *Yersinia pseudotuberculosis* can cause abortion in cattle and goats, mastitis (inflammation of the udder) in goats, and orchitis (inflammation of the testes) in rams. Uterine infection has also been reported in some animals.

**Disease Symptoms in Humans:**

In some patients, *Yersinia enterocolitica* infection has been found to be acquired from the hospital environment. It can also cause arthritis and diarrhea. Common symptoms in children include fever, sore throat, abdominal pain, and bloody diarrhea. In older children and some adults, a fever accompanied by pain on the right side of the abdomen may occur. This can create confusion with the symptoms of appendicitis.

**Diagnosis: In Humans / Animals**

1. The mode of disease transmission, symptoms, and post-mortem examination of animals will help in diagnosis.
2. Apart from stool cultures, diagnosis is carried out by isolating and identifying the pathogenic bacteria from blood, bile, wounds, throat swabs, mesenteric lymph nodes, cerebrospinal fluid, or peritoneal fluid.
3. Diagnosis is also possible through Enzyme-Linked Immunosorbent Assay (ELISA) for detecting antibodies, Radioimmunoassay, and Polymerase Chain Reaction (PCR) tests.

**Treatment in Humans / Animals:**

Yersiniosis is usually a self-limiting disease. Often, treatment is not required. For severe infections, especially those related to immune efficiency, antibiotics can be used. As a remedy for diarrhea, water and electrolytes must be given to the body in the required amounts. Adequate nutritional food should also be provided.

**Disease Prevention and Control:-**

1. Do not feed raw or undercooked pork, especially parts of the intestines and stomach, to wild animals and domestic pets.
2. Staff working with wild animals, domestic pets, or farm animals must wash their hands thoroughly after handling the animals.
3. Safe food processing, regular water purification, and disinfection are ways to reduce the risk of infection.



## **Zoonotic Parasitic Diseases**

Diseases caused by parasites that are transmitted from animals to humans are called zoonotic parasitic diseases. Parasites or worms are organisms that depend on another host organism for food, shelter, and movement, and cause health problems for the host organism. From a One Health perspective, parasites that affect both humans and animals alike can be considered zoonotic parasites. Let us introduce some important zoonotic parasitic diseases found in Kerala.

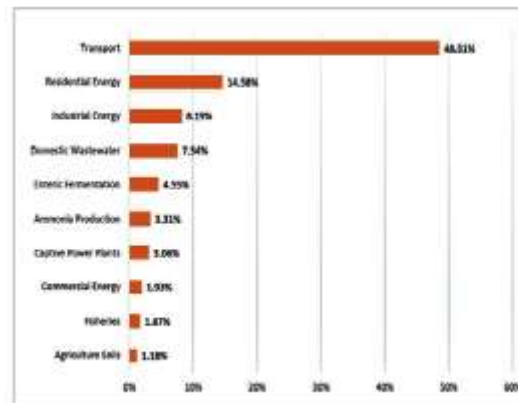
### **Hydatidosis**

Hydatidosis is a disease caused in humans and animals (goats, cattle, pigs) by the larvae of *Echinococcus* tapeworms found in dogs. A characteristic feature of this disease is the formation of fluid-filled ball-like spheres or cysts in the internal organs. Such cysts are known as hydatid cysts.

Fully grown tapeworms are found in the intestines of carnivorous animals such as dogs, jackals, and lions, which act as the definitive hosts. These tapeworms lay eggs inside the intestines, and the eggs reach the soil through excreta. From the soil, the worm eggs reach the intermediate hosts through food or water. Herbivores and omnivores like cloven-hoofed cattle and goats can act as intermediate hosts for the tapeworm. Humans act as accidental intermediate hosts. In these organisms, the shell of the eggs is digested in the stomach, and the larval form inside comes out. These larvae penetrate the intestinal wall and enter internal organs like the liver, lungs, spleen, and muscles. They grow inside these internal organs and become fluid-filled ball-like structures. The larvae found inside these cyst-like structures are what we call hydatid cysts. If the definitive host animals (dogs, carnivores) happen to eat the meat portions of an intermediate host animal containing such cysts, these larvae emerge, reach the intestine, and develop into fully grown tapeworms. It is inside these tapeworms that the worm eggs are formed. The eggs detach and reach the soil through the excreta of the host animal.

Depending on the species variation of the *Echinococcus* worms, there are three types of hydatid cysts:

- Cystic Hydatidosis:
- Alveolar Hydatidosis:
- Polycystic Hydatid Disease:



## Disease in Humans

The cysts grow and disrupt the functioning of internal organs. Symptoms such as liver enlargement, breathing difficulties, and vision problems may vary depending on the internal organ where the cysts are growing. If a cyst ruptures for any reason and the fluid inside leaks out, it can cause a fatal allergic reaction in the patient. However, alveolar hydatid cysts have the capability to spread throughout the body like cancer. Therefore, this disease can affect the functioning of more than one internal organ and even cause death.

## Disease in Animals

Hydatidosis is very common in animals. They often do not show any symptoms of the disease. Stunted growth and a decrease in milk production can sometimes be observed. It is frequently noticed during post-mortem examinations or during meat inspections at slaughterhouses.

## Diagnosis

Preliminary diagnosis is possible through imaging methods like Radiology and MRI. The disease can be confirmed through cytological examination of the fluid from the cysts. Tests like PCR and ELISA are also available.

## Treatment

If it is cystic hydatidosis, the cysts can be removed surgically. There is also a method in practice where deworming medications are injected directly into the hydatid cysts. Deworming medicines are effective in destroying the fully grown *Echinococcus* worms found in primary definitive host animals like domestic pets including dogs and cats.

## Disease Prevention

Maintaining hygiene is the most effective way to prevent hydatidosis. Those who interact closely with dogs should consume food or water only after washing their hands thoroughly. Methods such as giving deworming medicine to dogs in the correct dosage and intervals, effectively implementing stray dog control, making meat inspection mandatory in slaughterhouses, and destroying meat found with hydatid cysts can be adopted for disease prevention.

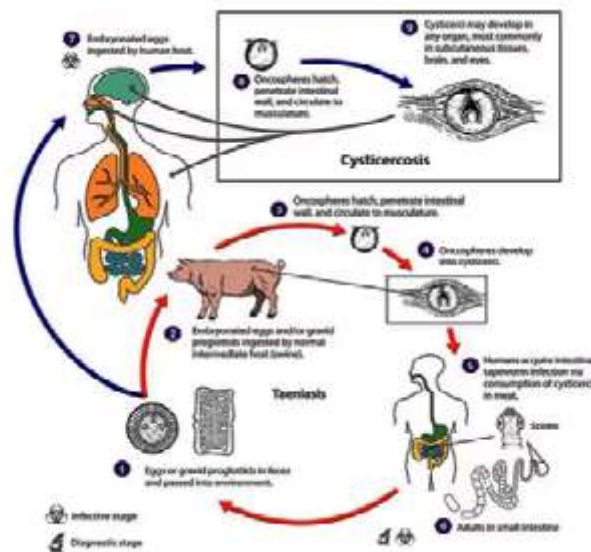
## Taeniasis & Cysticercosis

Taeniasis/Cysticercosis is a foodborne disease caused by the larvae (cysticercus) of tapeworms. Three parasitic tapeworms—*Taenia solium* found in pigs, *Taenia saginata* found in beef, and *Taenia asiatica*—are the causes of taeniasis in humans. Among these, *Taenia solium* causes major health problems. Cysticercus, the larva of *Taenia solium*, forms fluid-filled cysts in various parts of the body. This disease affects humans, and pigs play a crucial role in the life cycle of this tapeworm.

### Mode of Transmission:

An intestinal tapeworm infection (*Intestinal taeniasis*) caused by *Taenia solium* occurs when a person consumes raw or undercooked infected pork.

The infection can also occur by consuming eggs present in the excreta of tapeworm-infected pigs and humans. Pigs and humans become infected with the disease by consuming these eggs or gravid proglottids. Once the eggs or proglottids enter the body, they hatch in the intestine, penetrate the intestinal wall, enter the bloodstream, and migrate to one or more organs, where they develop into cysticerci within 60 to 70 days. Some cysticerci migrate to the central nervous system and cause severe consequences (*Neurocysticercosis*).



### Life Cycle of the *Taenia solium* Tapeworm

(English text diagram detailing the life cycle of Taeniasis and Cysticercosis between humans and swine)

### Disease Symptoms in Animals and Humans:

In animals, cysticercosis leads to the formation of cysts in bones, cardiac muscles, subcutaneous tissues, muscles, and inside the mouth. In humans, the symptoms of cysticercosis vary depending on the location and number of cysticerci. Cysticerci can form in bones, cardiac muscles, skin, subcutaneous tissues, lungs, liver, and inside the mouth. In most of these locations, they cause minor discomfort and resolve on their own.

However, sometimes cysticerci migrate to the central nervous system and cause Neurocysticercosis (NCC). This is a critical medical condition featuring severe epileptic seizures that can result in sudden death.

### **Diagnosis:**

Information gathered from the patient, physical examination, and neuroimaging studies (Magnetic Resonance Imaging [MRI] along with non-contrast Computed Tomography [CT] scan of the brain), as well as serological evaluation using Enzyme-Linked Immuno-electrotransfer Blot (EITB), are used for the diagnosis of neurocysticercosis. Antibody tests, antigen tests, and microscopic examinations are also utilized to diagnose the disease.

### **Treatment:**

Praziquantel, Niclosamide, and Albendazole can be used. Medications directed against tapeworms are effective.

In neurocysticercosis, destroying the cysts can cause the destruction of other nearby tissues. Therefore, specific treatment is required, and surgery may also be necessary.

### **Prevention and Control:**

To prevent cysticercosis, it is essential to make personal hygiene and safe food handling a habit.

The following various methods can be adopted for the control of *Taenia solium*. Immediate interventions:

- Treatment of taeniasis in humans.
- Treatment for worm infection in pigs.

### **Other Necessary Measures:**

- Public health education including hygiene and food safety.
- Improved sanitation—avoiding defecation in open areas.

### **Measures Required for Fundamental Social Changes:**

- Safe and hygienic pig farming.
- Improved meat inspection and processing of meat products.

### **Trichinellosis / Meat Worm Infection**

*Trichinella spiralis* is a roundworm found in pigs and other animals. The worms are found in the intestines. Their eggs hatch inside the worm's body itself, and the larvae emerge. These larvae travel through nerves to reach the muscles, where they reside in the form of cysts. If humans or other animals happen to consume meat containing such cysts, the cysts are digested in the stomach, and the larvae emerge from them. These then reach the small intestine, achieve full growth, and complete their life cycle.

The adult worms living in the intestine do not cause any significant disease to the host animal. However, serious symptoms manifest when their larvae travel through the nerves and reach the muscles to turn into cysts. In humans, muscle pain and swelling of the eyes are the main symptoms. Due to an allergic reaction to the cysts, red patches, itching, burning sensation, and coughing are often experienced in the body. Rarely, *Trichinella* larvae also reach the cardiac muscles and the brain. Inflammation of the brain (encephalitis), swelling of the brain, and inflammation of the cardiac muscles (myocarditis) would be the resulting consequences. Inflammation of the cardiac muscles can lead to death.

Infected wild animals often become weak or die in this manner, becoming food for other animals. This is how the transmission of the disease occurs. Generally, transmission of the disease does not occur from human to human or to other animals. Pigs acquire the disease from eating dead rats that were infected. During microscopic inspection of meat, *Trichinella* larvae in the form of cysts can be found inside muscle cells.

This method can be adopted for diagnosis. Meat inspections in slaughterhouses utilize this method. Apart from this, methods such as PCR, ELISA, and capsule examination are also used for diagnosis. Deworming medicines can be used to destroy adult worms present in the intestine. However, medicines are not available to eliminate the cysts located in the muscles. Therefore, treatment based on symptoms is adopted.

Eat meat only after cooking it properly. Implement scientific meat inspection. Rearing pigs in a hygienic environment helps to destroy *Trichinella* cysts and reduce disease transmission. Preventive methods include keeping pigsties clean and providing deworming medicines to the animals in the correct dosage and intervals.

### **Hookworm Skin Disease (Cutaneous larva migrans / CLM)**

#### ***Cause of the Disease:***

Skin diseases caused in humans by the larvae of hookworms found in animals are generally known as CLM. Most CLM diseases are caused by hookworms belonging to the *Ancylostoma* genus. These worms cause infection in animals such as dogs, cats, and other carnivores. These carnivorous worms, found in the intestine and stomach, lay eggs in the intestine, and the worm eggs reach the soil through the animals' excreta. The eggs hatch in the soil, and larvae emerge. These grow and develop into the L3 larval stage, which is capable of penetrating the skin of humans and animals to enter the body. These larvae then travel through various organs of the body (primarily through the lungs and liver) and eventually reach the intestine, where they turn into fully grown hookworms. In this manner, their life cycle is completed.

CLM symptoms manifest when these L3 larvae penetrate human skin and enter underneath the skin (subcutaneous tissue).



## Disease in Animals

Symptoms of *Ancylostoma* worm infection in animals can vary depending on the number of worms present. Due to the penetration of larvae during the initial stage of worm infection, symptoms of dermatitis can be seen on the legs of animals. Other disease symptoms manifest when the larvae migrate from the skin to the internal parts of the body. Pneumonia can occur during their migration through the lungs. Fully grown worms are blood-feeders. Consequently, anemia, hemorrhage, diarrhea, dehydration, loss of appetite, and weakness can occur in cats and dogs. Severe anemia can be fatal to young animals.

## Disease in Humans

Although the larvae of animal hookworms have the ability to penetrate human skin and enter the body, they never reach the digestive tract to achieve full growth. However, allergic-like symptoms occur in the skin and other organs due to the migration of the larvae. These symptoms can persist for a few weeks, or sometimes even months. The main symptom consists of thin, red, winding, thread-like tracks or eruptions seen on the hands, feet, and thighs. Larvae migrating toward the lungs can cause conditions like pneumonia and eosinophilia.

## Diagnosis

Diagnosis is possible through the skin lesions that are formed. In animals, worm eggs can be detected through fecal examination.

## Treatment

Medications like Ivermectin and Thiabendazole are effective for CLM.

## Disease Control

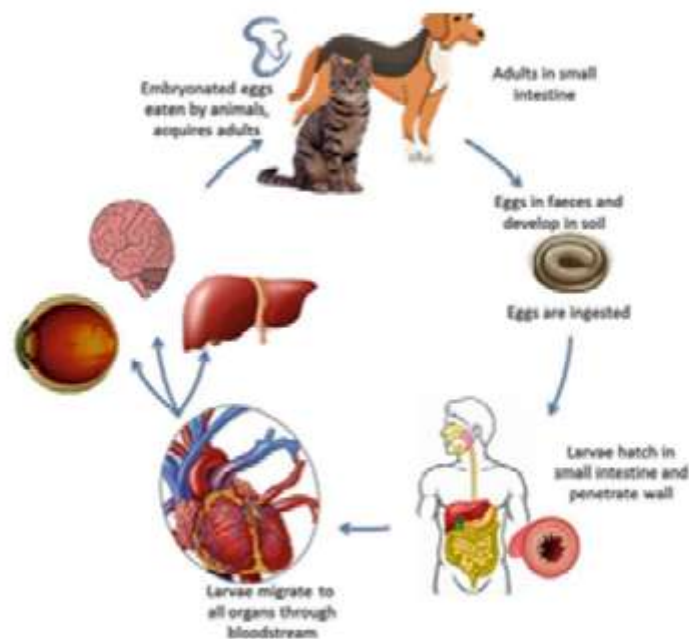
Wear footwear while walking, give deworming tablets to pets like dogs and cats at regular intervals, train animals to defecate and urinate only in litter boxes or designated toilets, and promptly remove excreta if they defecate in public places.

## Roundworm Disease / Visceral Larva Migrans (VLM)

VLM is a disease caused in humans by roundworms belonging to the *Toxocara* species found in animals. Similar to CLM caused by hookworms, the primary cause of VLM disease is the physical immune response or allergy triggered by the migration of the larvae.

Dogs act as a primary reservoir for humans to contract the infection. The disease can be acquired from soil, hands, food, and water contaminated with worm eggs. Eating undercooked meat (especially liver) can also cause VLM. Dog fur containing worm eggs is another main source of infection.

Fully grown worms found in the intestines of animals lay eggs, and these eggs reach the environment through excreta. In the soil, infective L3 larvae develop inside these eggs. These worm eggs reach the digestive system through food or water, or directly through the mouth. From the eggs that arrive in this manner, L3 larvae emerge, reach full growth in the intestine, and thereby complete their life cycle. However, some of the hatched larvae penetrate the intestinal wall and reach the liver, lungs, and heart. Due to this migration of larvae, the body's immune system reacts, and allergies occur. If the larvae die in extra-intestinal organs, they transform into cysts.



### Disease in Animals

Symptoms such as intermittent diarrhea, anemia, lethargy, a dull coat, and a sunken abdomen are observed in animals.

### Disease in Humans

Symptoms like eosinophilia, the appearance of red patches on the body, joint pain, and coughing can be seen in the initial stage of the disease. When the larvae die, the organs containing the dead larvae become affected by the disease. The eyes, brain, and lungs are the organs most frequently affected.

### **Diagnosis**

Hematology (to detect eosinophilia), ELISA, PCR, and methods like MRI and X-ray to visualize cysts are effective. Worm infestation in animals can be diagnosed through fecal examination.

### **Treatment**

Benzimidazole anthelmintic drugs such as Albendazole and Mebendazole.

### **Disease Control**

VLM (Visceral Larva Migrants) can be controlled through personal hygiene. Those who closely interact with domestic animals must wash their hands with soap and water if they touch them. Controlling stray dogs and eradicating their worm infestation is necessary to control VLM.

### **Fascioliasis / Fluke Worm Disease**

Flatworms or flukes that cause disease in animals rarely reach humans accidentally and cause diseases. *Fasciola hepatica* and *Fasciola gigantica*, which affect the liver in cattle and goats, and *Fasciolopsis buski*, which affects the intestines of pigs, are the fluke worms capable of causing disease in humans. Their life cycle is complex and involves various types of snails and certain aquatic plants.

Fluke worms belonging to the *Fasciola* species are found in the liver of humans and animals. The main symptoms are severe liver inflammation (enlargement), blockage of bile ducts, and cirrhosis (hardening) of the liver. The disease can also be contracted by consuming undercooked liver containing immature fluke worms. In animals, especially in goats and sheep, symptoms such as liver disease, diarrhea, edema (fluid retention) in the body, physical weakness and emaciation, and liver infection are commonly observed due to *Fasciola* flukes.

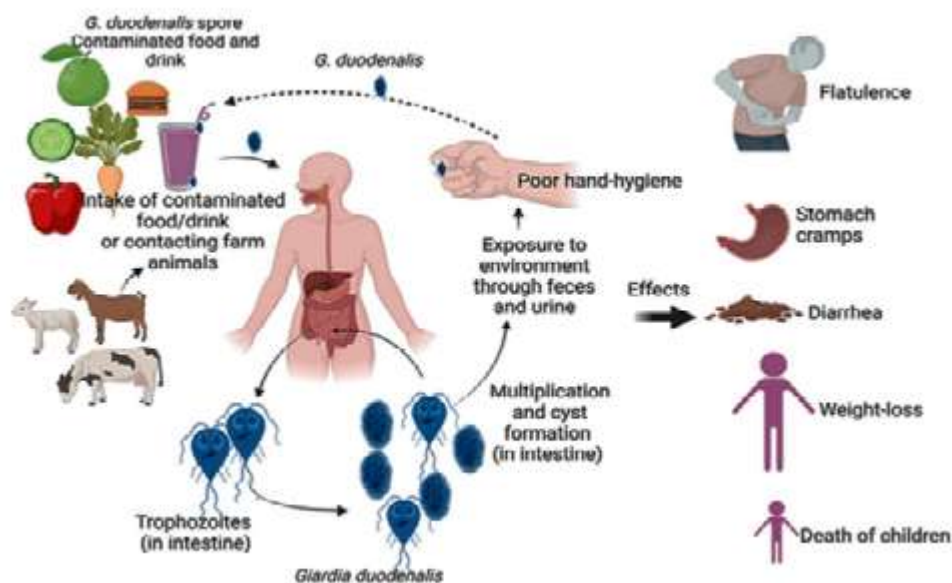
*Fasciolopsis buski* is a fluke worm found in the small intestine that affects pigs and humans. It is one of the largest fluke worms. Transmission occurs by eating improperly cooked water caltrops (Singhara) or Calcutta tubers containing metacercariae. Severe abdominal pain, diarrhea, and abdominal distension (constipation/bloating) are the main symptoms of this fluke infestation. However, pigs usually do not show any such disease symptoms.

Unlike in animals, it is rare for fluke worms to reach full maturity and lay eggs in humans. Nevertheless, in some places, humans act as primary hosts. Fluke eggs may be found in the feces of such patients. The presence of these eggs can be utilized for diagnosis. Additionally, methods like PCR and ELISA are helpful for diagnosis. Anthelmintic drugs against flatworms are effective for fluke disease in both humans and animals.

### **Giardiasis**

Giardiasis is a diarrheal disease caused by a single-celled organism (protozoa) called *Giardia lamblia* in both humans and animals. Infection occurs through water, milk, or meat contaminated with feces containing oocysts from infected animals or humans. Farmers, veterinarians, and livestock inspectors who closely interact with infected animals are highly

susceptible to contracting this disease. Infected calves shed a high volume of *Giardia* oocysts. Although it is more commonly found in calves, adult animals act as reservoirs for the infection.



## Symptoms

- In Calves: Cough, fatty dung (steatorrhea), weight loss, and stunted growth are the symptoms observed.
- In Humans: The primary symptoms are diarrhea, flatulence (gas), and stomach pain. Recurrent diarrhea can also be observed in some cases. Diagnosis can be confirmed through fecal examination. Medications are available.

## Prevention and Control Measures

- Avoid the mixing of human/animal feces into drinking water sources.
- Always wash hands thoroughly with soap and water after using the restroom and after meeting animals or animal waste.
- Boil or filter water before drinking if it is sourced from ponds, streams, or rivers.

## Thelaziasis / Eye Worm Disease

Thelaziasis is a parasitic worm infection that affects the eyes of cattle and horses. Rarely, this disease has also been found in humans. This worm is transmitted to other animals and humans by a species of flies called *Musca* (houseflies) from infected animals. When these flies feed on secretions from the eyes of infected animals, the first-stage larvae of the worm enter the fly's body. The larvae develop into an infective stage inside the flies and then accidentally reach other animals or humans through the flies.

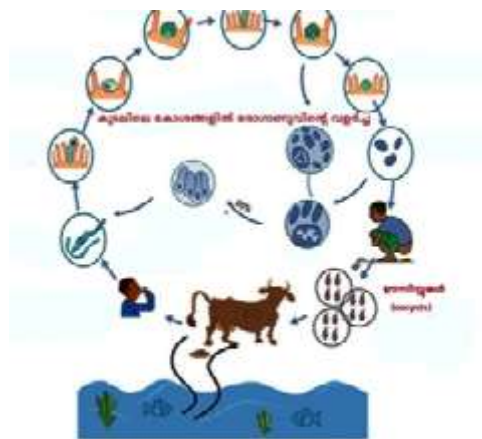
In animals, especially cattle, this disease causes symptoms such as swelling of the eyes, redness, watery eyes, corneal opacity due to heavy infestation, and blindness. Similar disease symptoms are observed in humans as well. Adult worms are found under the eyelids of the

conjunctiva and in the tear ducts. The larvae of these worms can be seen in eye secretions. This factor can be used for disease diagnosis.

The most effective treatment is to physically remove the worms from the eyes of the patient using forceps. In areas with a high density of flies, particularly near livestock shelters like cattle sheds and horse stables, there is a risk of disease transmission. Using fly nets in stables is effective in controlling the flies.

### **Cryptosporidiosis**

Cryptosporidiosis is a contagious disease caused by single-celled organisms (protozoa) called *Cryptosporidium*. This disease is primarily a pathogen that causes enteritis or diarrhea in calves. This organism completes a major part of its life cycle in the small intestine. During the stages of its life cycle, it produces thick-walled structures known as oocysts. These reach the soil or water bodies through the feces of infected humans or other animals. These oocysts then reach other animals or humans through water and food. Once the oocysts reach the small intestine, 'sporozoites' emerge from them, attach to the cells of the small intestine, and cause the infection.



### **Cryptosporidium Disease in Animals**

*Cryptosporidium* infection has been detected in various animals, including poultry, mice, turkeys, cattle, dogs, pigs, and goats. Infected animals can transmit the disease to humans. A key feature of this disease in cattle is very loose, yellowish diarrhea. The infection can spread if clothing and footwear used on livestock farms meet the waste/feces of infected animals. Infected calves act as the primary source of the infection.

### **Cryptosporidium Disease in Humans**

In healthy individuals with good immunity, *Cryptosporidium* infection is only a mild illness. Common symptoms include a mild fever, abdominal pain, nausea, and loss of appetite. Some patients may also experience loose diarrhea containing mucus and froth.

However, the severity of the disease will be much higher in immunocompromised patients (such as those affected by HIV/AIDS, patients undergoing treatments like chemotherapy or radiotherapy that lower immunity, patients taking certain types of immunosuppressive medications, and those with primary immunodeficiency diseases). Symptoms can last from 7

days up to 1 month. Extremely severe diarrhea leads to dehydration in the body. The symptoms are not limited to the digestive tract; it can also affect other organs such as the lungs, liver, and pancreas. Consequently, the disease leads to numerous complications and, ultimately, death.

### **Diagnosis**

Oocysts can be detected through a microscopic examination of the dung/feces of infected humans or animals. In addition to this, methods like PCR and ELISA are also available.

### **Treatment**

Symptomatic treatment is used based on the clinical presentation. Medications like Paromomycin are available.

### **Disease Control**

The onset of the disease can be prevented by maintaining strict personal hygiene. Practice proper handwashing before and after meals, and after using toilets. Wash hands properly after touching animals, especially cattle with symptoms or domestic dogs. Avoid swimming or bathing in contaminated water, rivers, or ponds. Wash fruits and vegetables thoroughly before cooking, avoid eating uncooked food, and use clean water to wash vegetables.

The spread of Cryptosporidiosis can be prevented by boiling drinking water, washing hands after handling clothes contaminated with animal feces, and avoiding contact with domestic animals, especially cattle suffering from diarrhea. No preventive vaccine is available for this disease.

### **Toxoplasmosis**

Toxoplasmosis is a parasitic, contagious zoonotic disease caused by a parasite called *Toxoplasma gondii*, which lives inside host cells. This infection can cause serious problems, particularly in pregnant women and immunocompromised individuals.

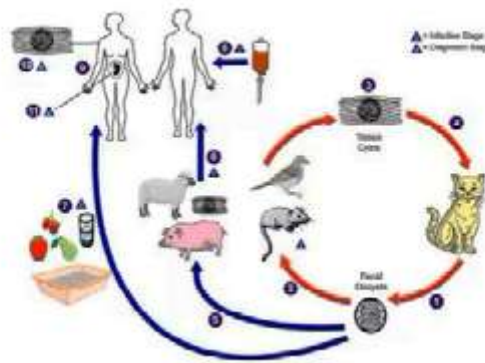
### **Causes and Mode of Transmission:**

*Toxoplasma gondii* is a parasite found in humans, animals, and birds, and cats play a major role in its life cycle. Cats contract the disease by consuming small, infected animals. Subsequently, through their feces, they contaminate the soil and other surroundings. Humans contract Toxoplasmosis either by accidentally ingesting the eggs excreted in cat feces, by consuming contaminated food or water, or directly from an infected mother.

### **The primary causes of contracting the infection are listed below:**

- Eating undercooked meat (e.g., beef, mutton, pork, poultry, etc.).
- Eating unwashed or unpeeled fruits and vegetables.
- Handling meat without washing hands.
- Situations involving contact with unwashed knives, cutting boards, contaminated soil, or other food items.
- Contaminated drinking water.
- Close contact with cats.

## Life Cycle of Toxoplasma



### Disease Symptoms in Animals and Humans:

In animals, symptoms are often not observed. Toxoplasmosis causes abortion in goats and pigs. In young animals and those with low immunity, symptoms such as fever, fatigue, swelling of the lymph glands, and pneumonia may occur.

Most healthy individuals do not show any specific symptoms. At the same time, clinical symptoms can include fever, swelling of the lymph nodes, and muscle pain. Severe cases can affect the brain, lungs, eyes, heart, or liver. Pregnant women are at a higher risk. The infection is transmitted to the fetus during pregnancy and at the time of delivery. If the infection occurs at the beginning of pregnancy, it aggravates the condition more for the mother. It can lead to various problems such as causing damage to the baby's eyes, nervous system, skin, and ears, as well as premature birth.

### Diagnosis:

In the diagnosis of Toxoplasmosis, blood tests can be conducted to detect antibodies produced in the body against *Toxoplasma gondii*. Polymerase Chain Reaction (PCR) tests can also be utilized for diagnosis. Screening during pregnancy or prior to conception helps in detecting the infection in the fetus.

### Treatment:

Treatment for Toxoplasmosis depends on the severity of the disease. Treatment is usually not required for healthy individuals with mild symptoms and good immunity. Nevertheless, anti-parasitic drugs may be prescribed for severe cases of Toxoplasmosis or for pregnant women.

### Prevention and Control:

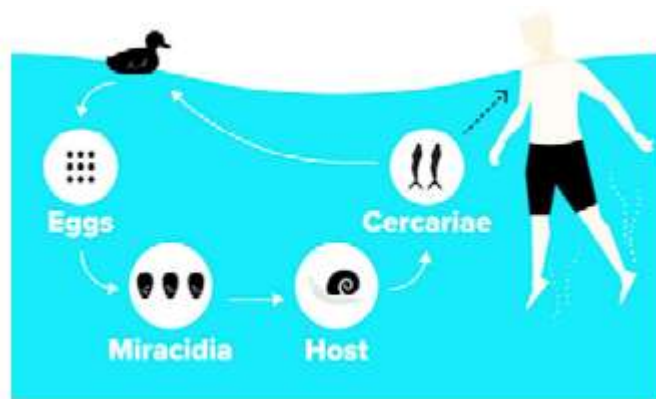
Practicing personal hygiene habits—such as cooking meat thoroughly, washing fruits and vegetables, and avoiding unpasteurized goat's milk or raw meat—can prevent Toxoplasmosis. Washing hands after handling soil or pets, and avoiding environments prone to contamination are essential preventive measures. Additionally, it is best for pregnant women to avoid handling cats to reduce the risk of contracting the disease.

### Cercarial Dermatitis

Cercarial dermatitis is a type of skin disease observed in those who work in agricultural fields or those who swim and bathe in ponds and water reservoirs. Cercariae are the larvae of blood

flukes (*Schistosoma*). The cercariae that cause skin disease in humans are the larvae of blood flukes that infect birds.

Blood flukes residing in the blood vessels of a bird's stomach lay eggs in the intestine, and these eggs reach water bodies through the bird's droppings. These eggs hatch into a larval form called Miracidia, which enters the bodies of snails living in the water and transforms into Sporocysts. Subsequently, these Sporocysts develop into Cercariae and are shed from the snail's body. These Cercariae penetrate through the skin to re-enter the bird's body, where they develop back into adult worms, thereby completing their life cycle. Cercariae can also accidentally infect humans from water bodies.



- **Eggs:** Deposited by water birds (like ducks) into the water.
- **Miracidia:** The hatched larval stage that searches for an intermediate host.
- **Host:** An aquatic snail where the parasite multiplies.
- **Cercariae:** The free-swimming larval stage released from the snail, which accidentally targets humans in the water instead of returning only to the bird host.

Cercariae that penetrate human skin do not complete their life cycle. The presence of Cercariae in the skin triggers a strong allergic reaction, resulting in symptoms such as unbearable itching, burning sensations, and skin rashes/swelling. This type of skin disease caused by Cercariae has also been found in dogs and rabbits. Cercariae that accidentally enter non-bird hosts, including humans, typically die right beneath the skin without being able to reach full maturity and become blood flukes. The remains of these dead cercarial larvae can subsequently cause severe allergies and skin nodules.

Cercariae can be spotted through a microscopic examination of the water. Taking necessary precautions when bathing or swimming in water where Cercariae are present, or when working in muddy agricultural fields infested with them, is the primary safety measure to prevent this skin disease. These precautions include wearing thick footwear and swimwear and wiping the skin dry immediately after coming out of the water to help remove clinging Cercariae.

### **Leishmaniasis / Black Fever**

Leishmaniasis, also known as Black Fever (Kala-azar), is a zoonotic disease caused by single-celled microscopic organisms (protozoa) belonging to the genus *Leishmania*. This disease is transmitted by sandflies belonging to the *Phlebotomus* genus, which feed on the blood of both

humans and animals. More than 20 species of *Leishmania* and around 90 species of sandflies are known to transmit the disease.

### **Disease Transmission**

Black fever is transmitted through the bite of female sandflies that act as disease vectors. Once the pathogens enter the blood through the bite, they reach the white blood cells, attain full maturity, and cause black fever disease in the internal organs. When sandflies suck blood from an infected patient, the cells containing the pathogens enter them. The pathogens then emerge from these cells and complete a part of their life cycle first in the midgut (stomach) and later in the mouth of the sandfly. In the final stage of the life cycle within the sandfly's body, the black fever pathogens reach a needle-like part called the proboscis, which helps the sandfly suck blood. When sucking the blood of a host, the pathogens are injected into the host's blood via the proboscis. Their life cycle is completed as these pathogens reach the macrophages inside the host's body.

### **Disease in Humans**

#### ***Black Fever Affecting Internal Organs (Visceral Leishmaniasis / VL)***

Visceral Leishmaniasis (VL) is the most severe form of black fever disease and can be fatal if left untreated. It is caused by a type of black fever pathogen called *Leishmania donovani*. Intermittent fever, weight loss, enlargement of the liver and spleen, and anemia are the primary symptoms of this disease. Additionally, at the time of infection, a dark or ash-colored discoloration of the skin may occur. In some individuals whose disease symptoms have been cured, a condition is observed where the remaining black fever pathogens in the body become active again, attack skin cells, and manifest as sores/lesions on the skin. This is called Post-Kala-Azar Dermal Leishmaniasis (PKDL). Such sores usually appear on the face, the upper parts of the hands, and the torso. Individuals with PKDL are considered a biological reservoir for the *Leishmania* infection. In Leishmaniasis patients who are also affected by HIV, the disease will be extremely severe. A high mortality rate and the disease remaining uncured despite treatment are observed in these immunocompromised patients.

#### ***Black Fever Affecting the Skin / Cutaneous Leishmaniasis (CL)***

Cutaneous Leishmaniasis is the most frequently observed variant of the black fever disease. The characteristic feature of this variant is the formation of sores on the skin that never seem to heal. The mortality rate for this variant is lower compared to the visceral (internal) infection.

#### ***Mucocutaneous Leishmaniasis (ML)***

The characteristic feature of this variant of black fever is the partial or complete destruction of the mucous membranes of the nose, mouth, and throat.

### **Disease in Animals**

The species that primarily affects domestic animals is *Leishmania infantum*. The main biological reservoirs for this pathogen are dogs and small rodents belonging to the rat family. Additionally, wild animals belonging to the canine family, such as wolves, foxes, and jackals, can act as vectors for the black fever pathogen.

In dogs and other animals, black fever manifests primarily as a skin disease. The main symptoms of black fever in animals include the formation of severe, non-healing sores on the skin, hair loss (alopecia), physical exhaustion, weight loss, and the appearance of lesions in the eyes and nose. Just like in humans, the type of black fever that affects internal organs is also observed in animals, and it is often fatal. Transmission of the disease to humans can occur from infected dogs via sandflies.

### **Diagnosis**

The black fever pathogens can be detected through cytological/cellular examination of samples taken from skin sores of infected animals or humans. Internal organs can also be examined in a similar manner. In addition to this, diagnostic methods such as antibody tests and PCR are also available.

### **Treatment**

Medications such as Sodium stibogluconate (SSG), liposomal amphotericin B, miltefosine, paromomycin, and pentoxifylline are used for the treatment of black fever.

### **Disease Prevention and Control**

- Control of Sandflies:
  - Those who need to go outdoors during times when sandflies are most active—specifically before sunrise and after sunset—should only do so wearing protective clothing such as gloves, socks, and thick garments to avoid being bitten.
  - Insecticides can be used if necessary, in places where sandflies hide, such as cracks in walls and domestic dog kennels.

Furthermore, the diagnosis and treatment of the disease in animals is essential to prevent the transmission of black fever to humans.

### **Amebic Meningoencephalitis (Naegleria Disease)**

Primary Amebic Meningoencephalitis (PAM) is a fatal brain disease caused in humans and animals by organisms belonging to the ameba group, which are single-celled microscopic organisms. These microorganisms are free-living in water. However, they can accidentally enter the bodies of humans or animals, reach the brain, and cause a fatal infection. Primarily, an ameba species named *Naegleria fowleri* causes the most fatal brain disease. This disease has been reported in many parts of India, including Kerala. They are commonly known as the 'brain-eating ameba'.



The overlapping circular diagram illustrates the interaction between the ameba and its hosts:

- Top Circle (Naegleria): Shows the microscopic ameba.
- Left Circle (Water bodies): Represents freshwater environments like lakes and rivers.
- Right Circle (Humans): Shows the human brain and nasal passage as targets of infection.
- Bottom Circle (Animals): Shows livestock and animals that can also be affected.
- Center Core (Single-celled organism): Highlights that the root cause linking all these elements is the single-celled pathogen.

*Naegleria fowleri* is primarily found in lakes, ponds, wells, and underground water. They have also been detected in rainwater harvesting tanks, tap water, and plumbing pipes. The contamination of water bodies through human activities—such as the mixing of animal waste, washing clothes, and discarding waste—as well as natural disasters like floods, aids the growth of *Naegleria fowleri* and other free-living amoebae. These amoebae prefer to live in warm water. Climate change and rising global warming are considered reasons for the growth of this amoeba. Most infections occur during the summer season. Increased human water activities and recreation during hot weather increase the risk of the disease.

The probability of *Naegleria fowleri* occurrence is higher in ponds and water bodies that have an abundance of algae and other organic waste. When humans or animals swim or bathe in such water bodies, the trophozoites (the organic form of the amoeba) happen to enter the nostrils via the nose. From there, they travel through the nerves to enter the brain. Moving from the brain into the meninges, the trophozoites multiply and cause fatal Primary Amebic Meningoencephalitis.

### **Naegleria Disease in Animals**

Naegleria infection has been reported in cattle, sheep, rhinoceroses, and tapirs. Additionally, it has been found that the disease can occur in guinea pigs, goats, and mice. There is also a possibility of the disease occurring in domestic dogs. In cattle, symptoms such as aggressive behavior, isolation from the herd, uncontrolled body movements, loss of appetite, lack of alertness, becoming bedridden, weakness in limbs, loss of consciousness, and death have been reported.

## **Naegleria Disease in Humans**

Initial symptoms begin within one to twelve days after infection. In the beginning, this bears a resemblance to the symptoms of bacterial meningitis. Headache, fever, nausea, and vomiting are included in the early symptoms. After the onset of symptoms, the disease complicates progressively through stiffness of the neck (stiff neck), loss of the ability to think, loss of sensitivity to people and surroundings, loss of spatial and time awareness, epilepsy (seizures), hallucinations, loss of consciousness, and later death.

### **Diagnosis:**

If the patient's cerebrospinal fluid is subjected to cellular examination, *Naegleria* trophozoites can be seen. Additionally, PCR, IHC (Immunohistochemistry), and cytological examination are also helpful for disease diagnosis.

### **Treatment**

Since it is a disease with a very high mortality rate, treatment often does not yield results. For treatment, medications such as Amphotericin B, Azithromycin, Miltefosine, and Dexamethasone are used.

### **Disease Control**

Avoid swimming or bathing in water bodies with an abundance of algae, decaying leaves, and other organic waste, or in ponds with untreated water. Since the possibility of contracting the infection is higher during summer, visiting such water bodies and bringing animals to graze or letting them down into the water to bathe there should be avoided. Swimming pools and similar facilities must be maintained by performing timely chlorination and filtration. Practices like avoiding dipping the head while bathing and using safety gear like face goggles and ear plugs when swimming can be adopted.

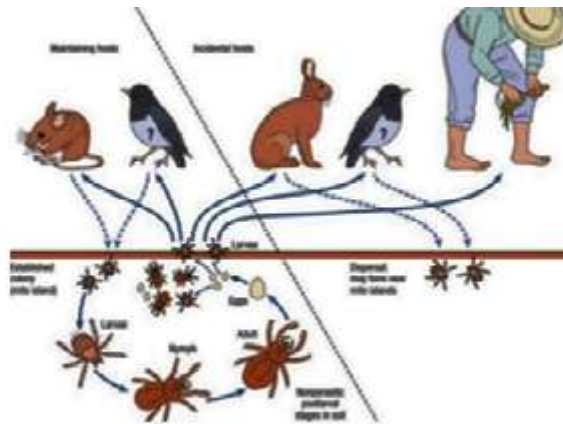
### **Scrub Typhus**

Scrub typhus is an infectious disease caused by a very small bacterium named *Orientia tsutsugamushi*, which was formerly included in the *Rickettsia* category.

This disease is found in the India-Pacific region.

### **Cause of the Disease**

The pathogen (*Orientia tsutsugamushi*) is transmitted by the larvae of tiny mites belonging to the Trombiculid mite family. These larvae are called chigger mites (Chiggers). Therefore, this disease is also known as "Chellupani" (mite fever). Various types of rodents found in pastures and small bushes are the reservoirs (carriers) of this pathogen. Hence, this disease is also known as Bush fever. In places where the disease is endemic, chigger mites act not only as disease vectors but also as reservoirs (storages). Once they acquire the pathogen, these mites can pass it on to the next generation through a process called transovarian transmission.



### Life Cycle & Transmission Loop

The illustration displays how the disease circulates between environments, maintaining hosts, and incidental hosts:

- **Maintaining Hosts:** Small rodents (like mice) and birds maintain the lifecycle of the mite colony.
- **Incidental Hosts:** Rabbits, certain birds, and humans working in fields or vegetation act as accidental or incidental hosts when bitten by the larvae.
- **Mite Life Cycle (in soil):** Shows the transition from Eggs  $\rightarrow$  Larvae (the infective stage that bites hosts)  $\rightarrow$  Nymph  $\rightarrow$  Adult. Non-parasitic post-larval stages remain in the soil, and dispersed mites may form new colonies.

### Disease Transmission and the Role of Animals

The disease is transmitted through the bite of a chigger carrying the pathogens. The infection is contracted while walking in pastures, lying down to rest, or engaging in other activities. Chigger mites are very small and difficult to see easily with the human eye.

The pathogen is found in gnawing animals belonging to the rodent family, such as rats, bandicoots, squirrels, and small rabbits. There is a possibility that chigger mites can crawl onto the bodies of cattle grazing in pastures or other domestic animals that play there. The possibility of them subsequently crawling onto the owner's body cannot be ruled out. Domestic animals are not considered to have a direct role in the transmission of the disease.

The risk of disease is higher during cold and rainy seasons.

### Disease Symptoms

Even if chigger mites carrying the pathogens bite domestic animals, they do not show any major disease symptoms. Nevertheless, it is good to observe domestic animals in endemic areas. Reservoir animals, including rats, also do not show disease symptoms. The marks left on the body known as eschar appear in a characteristic manner. This helps in diagnosing the disease. Marks that start as a small red swelling ( $1\text{ cm}$ ) gradually fill with fluid, rupture, and turn into wounds with a black crust forming in the center. If timely treatment is not received, the disease level can progress to pneumonia, inflammation of the heart muscles

(myocarditis), and brain inflammation (encephalitis). Disease symptoms generally begin 10 to 12 days after the mite bite.

### **Diagnosis**

The presence of eschars on the body helps with disease diagnosis. Laboratory testing facilities such as PCR and ELISA are also currently available for this. A blood test called the Weil-Felix test is also utilized for disease diagnosis.

### **Treatment, Prevention, and Disease Control**

Antibiotic treatment is effective. Doxycycline is the first-line drug for scrub typhus. No vaccine is available for this disease.

Rodent eradication, using disinfectants/insecticides (such as chlordane, lindane, permethrin) for mite control, adopting safety measures to avoid being bitten by chigger mites, and clearing bushes and pastures around residential areas are the primary preventive measures.

Do not let cattle graze in areas known to be infected. It is advisable to adopt mite control measures at intervals prescribed for domestic animals. Mite eradication must be carried out using insecticides in cattle sheds and surrounding areas, and steps should be taken to prevent the entry of rats and other rodents. Special attention is necessary as there is a likelihood of rodent infestation in places where cattle feed and other items are stored.

Avoid letting indoor pets, such as domestic dogs and cats, out to play in pastures or grass fields. Brush their bodies frequently and use control medications if necessary. In this way, the entry of mites into humans via domestic animals from rats and the surroundings can be prevented.

Those who go to grasslands, pastures, or similar places to rest or engage in other work should wear long clothing, boots or similar footwear, and use mite-repellent lotions to avoid getting bitten by mites.

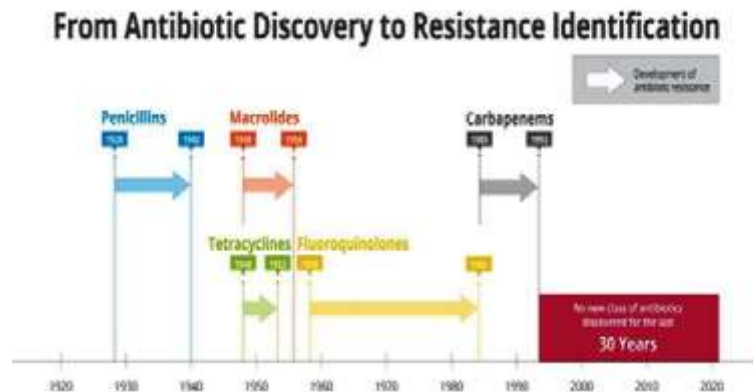
### **Antimicrobial Resistance (AMR)**



Antimicrobial resistance is a serious problem directly threatening modern medical science. The core of the issue is that pathogenic microorganisms develop resistance to medications. Antimicrobial resistance (AMR) is a major obstacle to the prevention and treatment of many infectious diseases. It has been discovered that in 2019, 1.27 million deaths occurred directly due to antimicrobial resistance, and 4.95 million deaths were indirectly associated with it. The

2022 Global Antimicrobial Resistance and Use Surveillance System (GLASS) report functions as a strong warning against the global spread of drug-resistant pathogens. The WHO predicts that by 2050, around 10 million people could die due to AMR.

Diagram: From Antibiotic Discovery to Resistance Identification



The mechanism by which pathogens nullify the defensive capacity of medicines is known as Antimicrobial Resistance or AMR. Resistance can occur in many ways. Certain variants of a microorganism (usually bacteria) cannot be destroyed even if two or more antibiotics are used. Pathogens with resistance to two or more antibiotics are called Multi-Drug Resistant (MDR) pathogens (they are also referred to as "superbugs"). It is the pathogens that develop antibiotic resistance (resistance to antibiotics), not humans.

The selection of first-line drugs is based on factors such as safety, availability, and cost. Although second-line antibiotics are effective against a broader range of pathogens (broad-spectrum), they carry higher risk, are more expensive, and may not be as readily available. Some pathogens may have acquired resistance to second-line drugs in addition to first-line medicines.

### Classification of Resistance

1. **Multi-Drug Resistance (MDR):** An infection/pathogen that develops resistance to one or more drugs in more than three antimicrobial categories.
2. **Extensively Drug Resistance (XDR):** A bacterium that shows resistance to all antimicrobial drugs except for those in two or fewer ( $\leq 2$ ) antimicrobial categories.
3. **Pan-Drug Resistance (PDR):** An infection/pathogen that develops resistance to all agents across all antimicrobial categories.

### Bacteria Resist Drugs Through the Following Processes

1. Restrict drug intake: Limiting the entry of the drug inside.
2. Structural alterations in cell wall: Making structural changes to the bacterial envelope/wall to prevent medicines from entering the bacteria.
3. Drug inactivation: Neutralizing the drug through the production of certain enzymes, for example, via  $\beta$ -lactamases.
4. Through Efflux pumps: Pumping toxic substances out of the bacterial cell.

5. Creating a Biofilm: Forming a protective shield or biofilm that prevents the medicine from penetrating the pathogen.
6. Through genetic mutation of the pathogen.

### **Genetic Mutations Can Occur Through the Following Processes**

- a. Genetic Mutation: An alteration or mutation that occurs in the nucleotide sequence of an organism's or virus's chromosome, extra-chromosomal DNA, or other genetic material.
- b. Conjugation: A type of genetic transfer that occurs when two bacterial cells come into direct contact with each other.
- c. Transduction: A method where genetic alteration is introduced from one bacterium to another via a virus.
- d. Transformation: This involves the direct absorption, integration, and expression of exogenous genetic material from its immediate surroundings.

Bacteria can also acquire resistance to antibiotics by obtaining genes through the pathways. The fact that most genes conferring resistance to antibiotics are in the easily transferable form of plasmids facilitates this transfer. When antibiotics are used, natural selection (evolution) causes an increase in the number of resistant pathogens. Such plasmids usually contain resistance against more than one antibiotic.

The use of antibiotics leads to an increase in evolutionary pressure on bacteria. This allows the number of drug-resistant bacteria to increase while others are destroyed. Consequently, a given type of pathogen will achieve resistance to an entire antibiotic class. This creates situations requiring the use of alternative antibiotics. Although such requirements are increasing, the number of drugs approved for use is low.

MRSA (Methicillin-Resistant *Staphylococcus aureus*), VISA (Vancomycin Intermediate *Staphylococcus aureus*), VRSA (Vancomycin-Resistant *Staphylococcus aureus*), ESBL (Extended-Spectrum Beta-Lactamase), VRE (Vancomycin-Resistant *Enterococcus*), and MRAB (Multi-Drug Resistant *Acinetobacter baumannii*) are examples of abbreviations related to antibiotic resistance. Although antimicrobial resistance is more commonly found in hospital-acquired infections, drug resistance is now widely seen in other pathogens transmitted from person to person within the community. Pathogens like *Staphylococcus aureus* and *Pseudomonas aeruginosa*, which cause hospital-acquired infections, naturally exhibit high resistance.

In recent times, strains of tuberculosis pathogens resistant to antibiotics have been detected in India. In 2011, the death of six people due to this type of tuberculosis infection created an atmosphere of panic on social media. However, it has been proven that these infections belong to the multi-drug resistant category and can be cured with treatment.

## Causes of AMR

The unscientific use of antimicrobial drugs is the primary cause for the development of AMR.

- **Treatment without proper dosing:** Treatments involving overdose, under dose, or a wrong schedule, rather than a proper dose. Self-treatment (in both animals and humans).
- **Unnecessary use:** Using them to prevent and control the onset of disease (prophylactic and metaphylactic) and giving antibiotics for viral diseases, etc.
- **Use for growth promotion:** Adding antibiotics to the feed of birds and animals, which is illegal in many countries today.
- **Unscientific waste management:** Waste contaminated with antimicrobial drugs coming from hospitals, farms, and slaughterhouses into the soil and water causes pathogens to acquire resistance.

## Is there a remedy for AMR?

Even if a prudent and responsible approach from everyone cannot completely eradicate it, it can reduce the speed at which AMR develops. The time has long passed to move forward by rationally regulating the use of antibiotics.

## Dos and Don'ts

- Use antibiotics and other medicines (for humans, animals, and birds) only on a doctor's recommendation; self-medication must be avoided.
- Complete the full duration of treatment (even if symptoms disappear).
- Do not consume milk, meat, or eggs during the prescribed withdrawal period after treatment has been administered.
- Do not discard leftover medicines onto the land or into water bodies after use. Utilize government systems (such as Haritha Karma Sena, etc.).
- Prevent diseases by giving timely immunizations/vaccinations. This will reduce the use of medicines.
- Maintain health and reduce the risk of disease through nutritious food.
- Utilize alternative treatment methods as appropriate (Ethno-veterinary, Probiotics, Prebiotics, Phage therapy, Immunotherapy, etc.).
- Do not administer (do not use) antibiotics for viral infections.
- Strengthen biosecurity systems on farms.
- Prevent hospital-acquired infections (nosocomial infections) by implementing the IPC (Infection Prevention Control) protocol in hospitals.
- Create conditions to provide and receive proper treatment by strengthening disease diagnostic systems.
- Implement scientific waste management (in slaughterhouses, farms, hospitals, homes, and laboratories).

In short, this can only be reduced by cutting down the use of antimicrobials. It is a tragic truth to remember that new medicines are not being discovered at the rate at which pathogens are

acquiring resistance ("Antibiotic Pipeline is dry"). Therefore, a collective "One Health" approach from all levels is essential to prevent AMR.

## **Biosecurity**

Biosecurity is defined as the set of practices designed to protect humans, animals, and environmental health from pathogens. In a literal sense, the term biosecurity means the safety of living organisms. In 2003, the Food and Agriculture Organization (FAO) adopted biosecurity as a comprehensive framework that includes policies and regulations to protect agriculture, food, and the environment from biological hazards. Biosecurity is a preventive health strategy and a sanitary practice. Biosecurity is the most cost-effective and, at the same time, the most effective method for disease control. It is absolutely essential to practice biosecurity and infection prevention together to prevent and reduce the impact of disease in the community.

The European Animal Health Law (AHL; Regulation (EU) 2016/429) defines biosecurity as the sum of management and physical measures designed to reduce the risk of the introduction, development, and spread of diseases to, from, and within an animal population, or an establishment, zone, compartment, transport route, or any other facilities, surroundings, or location. The Food and Agriculture Organization (FAO) of the United Nations defines biosecurity as "the implementation of measures that reduce the risk of the introduction and spread of pathogens". Biosecurity measures result in reducing the likelihood of the emergence of new pathogens or reducing the internal spread of pathogens. The World Organisation for Animal Health (WOAH, formerly OIE) Terrestrial Animal Health Code defines biosecurity as "a set of management and physical measures designed to mitigate the risk of the introduction, development, and spread of animal diseases, infections, or infestations to, from, and within an animal population".

## **General Principles of Biosecurity**

### **1) Livestock Quarantine (Isolation) and Movement of Animals:**

- Controlling the movement of animals in a manner that reduces the likelihood of an infectious disease transmitting or spreading.

### **2) Hygiene of People, Equipment, and Vehicles:**

- Controlling the people, equipment, and vehicles entering an area to reduce the risk of infectious diseases.

### **3) Food and Water Security:**

- The quality of the food provided to animals is important.
- Pathogen-free food and water must be provided to animals.

### **4) Health Management, Monitoring, and Reporting of Animals:**

- Preventing and controlling diseases in animals through appropriate preventive vaccinations, regular monitoring of diseases, and immediately reporting disease outbreaks among animals.

#### 5) Public Awareness:

- All farmers, traders, and employees must understand the necessary biosecurity measures in their respective working villages, enterprises, or countries, and must take care to implement approved practices in their areas of responsibility.

### **Biosecurity - On Farms**

The introduction and spread of pathogens primarily occur through the following four pathways, and biosecurity measures must target these:

- Animals
- People
- Fomites (Non-living objects)
- Vectors

Pathogenic microorganisms infect animals through direct or indirect contact. By implementing biosecurity protocols, the risk of diseases entering and spreading across farms can be reduced.

In enterprises like farms, emphasis should be placed on biosecurity and biocontainment, and standard guidelines for Sanitation, Traffic control, Assessment, Isolation, Resistance, and Security (STAIRS) must be followed. For this, Standard Operating Procedures (SOP) and the active participation of owners, managers, and workers in enterprises, industrial establishments, and rural or urban communities are highly essential.

The presence of animals belonging to the same species increases the possibility of disease transmission. The animal trade plays a very large role in bringing pathogens to disease-free animals or areas. Newly purchased animals or birds must be kept isolated (Quarantine) for at least one month before being introduced into a unit. During this period, their health status can be assessed. Necessary preventive vaccinations and medications should also be administered. (Deworming, Disease screening, Vaccination)

Contact with wild animals has also been identified as a potential risk for disease transmission. This risk can be reduced through barrier fencing. Restricting the entry of other animals, people, and vehicles requires a secure perimeter wall or fencing (Compound wall, fencing), which is considered essential, especially in large farms. Control of vectors capable of transmitting pathogens to animals, especially birds, rats, flies, and other insects, must be implemented.

Visits by doctors who visit farms for the treatment or other primary care of animals, other animal health workers, and other individuals visiting farm ventures are likely to transmit disease to the unit. To reduce this risk, only necessary visitors should be allowed to visit the animal housing area/buildings; furthermore, these visitors must be provided with protective

clothing and footwear. Such protective clothing and footwear should be provided to all workers and visitors, and they should not be worn to any other unit or outside the venture.

To reduce and eliminate pathogens, dead animals should be removed and either burned, buried, or composted. To ensure the protection of other animals, manure, waste/bedding, etc., must also be removed scientifically. Contaminated feed and water can cause diseases. To reduce these risks, it is essential to ensure that feed sheds and water sources are protected from pests and other animals.

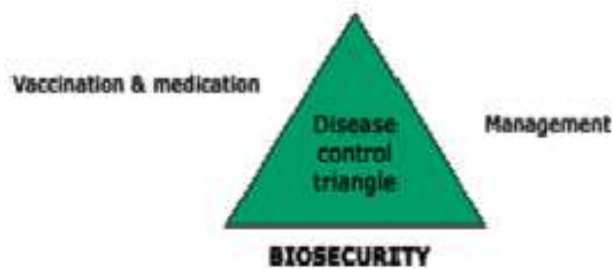
Only essential vehicles should be allowed entry into the ventures. By installing a perimeter fence, the entry of unauthorized vehicles can be controlled. Arrangements should be made to unload feed from outside the venture or to transport it into the vehicle.

Vehicles entering an establishment should enter and exit through a single point equipped with facilities for washing and disinfecting wheels. Using equipment contaminated with urine, faeces, and animal products (e.g., hair, feathers, saliva) can cause the onset and spread of infection. Disinfection of equipment must be a part of daily operations.

Farm workers should be discouraged or prevented from working in other ventures or raising similar animals. Employees should be discouraged from visiting other units, livestock markets, zoos, and slaughterhouses.

### **Biosecurity Protocols to be Adopted During Disease Outbreaks**

Biosecurity, medication/vaccination, and proper management of the farm are the three sides of the disease control triangle. In the event of a disease outbreak, the following biosecurity measures should be adopted:



1. Prevent unnecessary visitors.
2. Provide facilities for the cleanliness and disinfection of vehicles.
3. Remove or isolate affected animals/birds (Culling or Isolation).
4. Scientific waste management: The main way to prevent and control existing and new diseases is the scientific disposal of dead animals/birds/other wastes.
5. Feed should be purchased and stored only from safe locations.

6. Feed, equipment, and new animals all have the potential to introduce disease into farms. Therefore, newly arriving animals to a farm must be isolated for a specified period (quarantine) and monitored accurately to eliminate the risk of infectious diseases.
7. Equipment and feed must be disinfected.
8. Daily cleaning activities should be intensified.
9. If necessary, arrange for containment vaccination and treatment.
10. Safety of animal handlers: Use clean slippers and clothes exclusively for the farm, and when going outside the farm, one must take a bath and disinfect before leaving.
11. Inform the authorities about the disease outbreak in a timely manner (Reporting/Notification).

### **Main Animal-Derived Food Poisoning and Foodborne Infections from Animal Sources**

| <b>Food Poisoning</b>                |                                |                    |
|--------------------------------------|--------------------------------|--------------------|
| <b>Meat</b>                          | <b>Milk and Dairy Products</b> | <b>Egg</b>         |
| Campylobacteriosis                   | Campylobacteriosis             | Salmonellosis      |
| Salmonellosis                        | E. coli (STEC)                 | Campylobacteriosis |
| E. coli (STEC)                       | Salmonellosis                  |                    |
| Clostridium                          | Listeriosis                    |                    |
| <b>Diseases</b>                      |                                |                    |
| <b>Meat</b>                          | <b>Milk and Dairy Products</b> | <b>Egg</b>         |
| Brucellosis                          | Brucellosis                    | Salmonellosis      |
| Tuberculosis                         | Tuberculosis                   | E. coli            |
| E. coli                              | E. coli                        |                    |
| Listeriosis                          | Listeriosis                    |                    |
| Salmonellosis                        | Yersiniosis                    |                    |
| Yersiniosis                          | Giardiasis                     |                    |
| Visceral larva migrans               |                                |                    |
| Taeniasis                            |                                |                    |
| Toxoplasmosis                        |                                |                    |
| Fascioliasis                         |                                |                    |
| Trichinellosis / Meat worm infection |                                |                    |

## **Department of Forests and Wildlife**

### **Human-Wildlife Conflicts and Zoonotic Diseases**

When human activities increasingly encroach upon natural habitats, the potential for conflict between animals and humans increases. This leads to infectious diseases and public health threats.

### **Habitat Destruction and Increasing Human-Wildlife Interaction**

Deforestation and urban expansion: Clearing forests for agriculture, infrastructure, and residential areas forces wildlife into closer contact with humans. This increases the likelihood of disease transmission.

Scarcity of Natural Prey and Food Shortages: When habitats are disrupted, wild animals enter human settlements in search of food. They come into contact with livestock and people.

Encroachment on Wildlife Habitats: Agricultural expansion and land-use changes cause conflicts between humans and wildlife. This directly and indirectly leads to disease possibilities.

### **Wildlife Trade and Illegal Poaching**

Meat Markets: Handling, transporting, and selling wild animals especially in unhygienic conditions-creates environments suitable for zoonotic pathogens to spread to humans (e.g., SARS, COVID-19).

Trading and Consumption of Wildlife Meat: In areas where wildlife meat is a food component, hunting and consuming infected animals (e.g., bats, non-human primates) increases zoonotic risks like Ebola and Monkeypox.

### **Livestock-Wildlife-Human Interface**

Disease Spread Between Wildlife and Livestock: When domestic animals graze in forest areas or interact with wild animals, diseases like Rabies, Brucellosis, and Tuberculosis can spread from wild animals to livestock and eventually reach humans.

Intense Agriculture Near Wildlife Habitats: High-density livestock farming near forests creates breeding grounds for pathogens from animals. This increases the risk of spillover.

### **Climate change and behavioural changes in wildlife**

Changes in animal migration and behaviour: Rising temperatures and changes in natural habitats force wild animals to move to new regions. This introduces pathogens to new hosts, including humans and domestic animals.

Vector-borne disease expansion: Climate changes affect the population of mosquitoes, ticks, and fleas. This spreads zoonotic diseases such as Lyme disease and Malaria into new areas.

### **Human-Wildlife conflict causes the spread of diseases**

**Killing nuisance animals and handling their carcasses:** When farmers kill problematic animals (e.g., bats, monkeys, rats), improper disposal of the carcasses exposes humans to fatal diseases. Furthermore, conflicts with aggressive wild animals can lead to direct disease transmission, such as Rabies or Nipah virus.

## **Major Zoonotic Diseases Found in Kerala**

### **Viral**

1. Bird Flu (H5N1)
2. Swine Flu (H1N1)
3. Crimean-Congo Haemorrhagic Fever
4. Rabies
5. Japanese Encephalitis
6. West Nile Fever
7. Monkey Fever (Kyasanur Forest Disease)
8. Nipah

### **Bacterial**

1. Leptospirosis (Rat Fever)
2. Tuberculosis
3. Brucellosis
4. Anthrax
5. Salmonellosis
6. Shigellosis
7. Campylobacteriosis
8. Clostridium Infection

### **Parasitic Diseases**

1. Toxoplasmosis
2. Cysticercosis
3. Cryptosporidiosis
4. Giardiasis
5. Amoebiasis
6. Schistosomiasis

Vaikom Muhammad Basheer has a famous short story titled "*The Rightful Inheritors of the Earth*". The perspective beautifully shared in Basheer's story is that not just humans, but all living species, including cockroaches and worms, have an equal right to this earth. It also highlights a deep dissatisfaction with the atrocities committed by humans under the delusion of holding absolute authority over this earth. The human-wildlife conflict can be simply defined as the mutual clash generated between these co-inheritors of the earth for their respective survival. It is natural for conflicts to arise when both humans and wild animals' cross boundaries against each other for survival. We hold the complex responsibility of simultaneously protecting wild animals as forest conservationists and humans as fellow living beings. Wild animals breaching boundaries into human settlements often pose risks to human life, property, and agriculture. Similarly, situations arise where humans threaten wild animals for self-defence and, at times, for hunting.

Various kinds of dangers can occur due to human-wildlife conflict. Constant contact with wild animals creates the potential for various zoonotic diseases. If humans unexpectedly find themselves in front of wild animals, there is a risk of being attacked and severely injured. Apart from these, wild animals can also be the cause of certain non-contagious medical emergencies that require immediate treatment. Snakebites, honeybee attacks, and hornet stings are all examples of this.

### **Precautions to Avoid Zoonotic Infectious Diseases**

- Avoid close proximity to wild animals; those who handle wild animals or are involved in rescue operations must adopt safety precautions.
- Thoroughly understand the correct methods for using safety equipment.
- During times like monsoon and floods, when the likelihood of disease transmission is high, use preventive medications as required and directed by health workers.
- Carefully observe and understand the symptoms of various diseases in wild animals, domestic animals, and humans, and maintain a safe distance from such animals.
- If any symptoms of illness are spotted, seek medical treatment immediately.
- Ensure personal hygiene if there has been contact with wild animals.
- Those rescuing wild animals must sanitize and clean themselves using a sanitizer after the rescue process is completed.

### **Snakebites**

- In human-wildlife conflicts, the highest loss of human life occurs due to snakebites.
- A snakebite is a medical emergency that requires immediate medical assistance.
- Wrong treatment methods and delaying medical care lead to fatalities and major mishaps for snakebite victims.
- The Union Ministry of Health and Family Welfare has directed states to declare snakebite as a 'Notifiable Disease'.

### **What to Do in case of a snakebite**

- Calm and reassure the victim.
- Under no circumstances should the victim be frightened.
- Do not make them run or engage in strenuous activities.
- Wrap a bandage very gently over the bitten area in a manner that minimizes muscle movement as much as possible.
- Rush the victim as quickly as possible to the nearest hospital where anti-venom treatment is available.

### **What Not to Do in case of a snakebite**

- Do not tie a cloth tightly above the bite wound.
- Do not cut or wound the bitten area using sharp tools.
- Do not cause danger by experimenting with flawed remedies like venom-treatment (folk practices), traditional therapies, single-herb remedies, or applying stones.
- Do not attempt to suck out the venom from the bite wound with the mouth or by other methods.
- Do not scrub or wash the bitten area with soap or other substances, as this accelerates the spread of the venom.
- Do not try to capture the snake that bit, whether dead or alive.

### **Wildlife rescue operations and rehabilitation**

Wildlife rescue operations and rehabilitation involve safely capturing wild animals that enter human habitats and pose a threat, providing them with necessary care including medical treatment, and releasing them back into an environment suitable for them in a healthy condition.

The general public or anyone without expert training or legal permission should not, under any circumstances, attempt to capture or chase away wild animals. Immediately inform Forest Department officials regarding potential wildlife conflicts. To deal with such situations, Flying Squads operate within the Forest Department, and Emergency Operating Centers function within Forest Divisions.

Staff and volunteers involved in activities that handle wild animals—whether alive or dead—must strictly adhere to designated precautions.

- After safely handling each wild animal, perform disinfection using a sanitizer.
- Preventive vaccinations must be taken under a doctor's guidance in necessary situations.

- Those handling carcasses must undergo thorough disinfection after procedures such as post-mortem or burial.
- Samples from carcasses that are suspected or confirmed to carry a risk of disease should be collected with the assistance of a veterinary doctor, submitted to the Animal Husbandry Department for detailed examination, and subsequent actions should be taken after seriously analyzing the test results.

Kerala is known for its rich biodiversity. However, following the destruction of habitats and urbanization, human-wildlife encounters are on the rise. Wildlife rescue and rehabilitation operations are highly essential to minimize human-wildlife conflict, protect rare animals, and return them safely to their natural habitats. Formed under the leadership of the department, Rapid Response Teams (RRT) play a decisive role in these activities.

### **Role of Rapid Response Teams (RRT)**

RRTs operate at the district level to handle emergency wildlife rescue operations. Their primary responsibilities are:

- Rescuing wild animals that are in distress.
- Providing necessary medical assistance.
- Releasing them back into environments suitable for them.

### **Wild animals that are rescued**

**Snakes:** This is the most frequently rescued group. The Indian Cobra (*Naja naja*) and the Indian Rock Python (*Python molurus*) are generally the most rescued species. In addition to these, Russell's Viper, Common Krait, and King Cobra are also brought in for rescue.

**Mammals:** The Asian Palm Civet and the Small Indian Civet are the most commonly rescued mammals. Apart from them, the Bonnet Macaque, porcupine, golden jackal, jungle cat, and sambar deer also arrive for protection.

**Birds:** Owls, especially the Barn Owl, are rescued in larger numbers due to conflicts arising from human interactions. Furthermore, the Black Kite (kite) caught in power cables and whistling ducks, whose eggs are often discarded by drawing down nests, are also included among the rescued birds.

### **Some suggestions to mitigate human-wildlife conflict**

Conflicts between humans and wild animals are a continuous global phenomenon. There is no permanent, single solution for this. However, there are many ways to mitigate conflicts through proactive, scientific interventions and to ensure secure, mutual coexistence. Since the Wildlife Protection Act of 1972 ensures the right of wild animals to live, harming them inside or outside the forests is a punishable offense.

Human-wildlife conflict, which used to center around forest areas, has recently been observed in areas far away from forests as well. Such widening conflicts generally result in four types of impacts:

- Threat to human life
- Agricultural crop damage
- Livestock attacks
- Conflict over living space

Among these, the threat to human life is the most significant. Commonly, wild animals hunt only for food. Since humans are not the natural prey of wild animals, it can be assumed that such attacks against humans do not happen purposefully. Moreover, animals like elephants are herbivores. The second reason for wild animal attacks is the fear that these animals have toward humans. Barring a few instances, it is seen that most wild animals steer clear upon sensing human presence. Elephants and certain other animals often live opportunistically near human settlements in search of easily available food sources. It is mostly observed that attacks occur out of fear or when humans unexpectedly find themselves in front of these animals, resulting in accidents. Since such conflicts happen globally, their ecological, biological, and social causes have been widely studied today.

Remedies for human-wildlife conflict can be classified into two categories. One is to remove the wild animal that is causing the conflict. A very rarely used method is lethal culling. Necessary amendments have already been made to the laws so that panchayats can implement this in the case of wild boars. There are numerous non-lethal control methods. Among these, the method applied directly to 'Arikomban' (a rogue elephant) involved tranquilizing, capturing, and relocating him to another area. Erecting fences to keep wild animals away from human habitations and using pungent-smelling chemicals like 'Borep' developed by the Agricultural University to repel wild boars, are alternative methods. Changes in our lifestyle can also mitigate human-wildlife conflicts. For instance, a major reason for the proliferation of stray dogs in residential areas is the easy availability of organic waste. For wild animals like leopards, stray dogs are a prey that can be hunted without much effort. Scientific disposal of organic waste can control stray dogs to an extent, thereby reducing human-wildlife conflict.

Some of the activities that can be adopted by panchayats and various departments out of many such methods are listed below:

**People's participation-based activities and interventions to be undertaken by local governments to keep wild animals away from agricultural fields**

1. Prepare and implement a comprehensive policy framework suitable for maintaining the habitat system to avoid human-wildlife conflict at the panchayat level. For this, assistance and advice should be sought from the Kerala Agricultural University, the Kerala Forest Research Institute, and expert individuals.
2. Examine the root cause of human-wildlife conflicts and implement necessary scientific measures with the assistance of research wings.
3. Form Wildlife Conflict Vigilance Committees in Grama Sabhas with the representation of the Forest Department and conduct operations. Ensure official-public participation by including ward representatives, the Forest Department, the Agriculture Department,

the Revenue Department, the Police, farmers, and Adivasis in such committees at the ward level.

4. Conduct awareness programs for panchayat representatives regarding human-wildlife conflict and the necessary leadership interventions needed in such situations.
5. Formulate action plans for permanent solutions with expert assistance.
6. Consider directives to capture and remove animals that act as persistent nuisances during critical phases.
7. Implement measures like electric fencing, rail fencing, and hanging fences against wild elephants in necessary areas.
8. Ensure efficient coordination of various departments in conflict-affected areas. Since human-wildlife conflict has been declared a state-specific disaster, the services of various departments, including the Disaster Management Authority, are indispensable in this regard.
9. Set up a special fund at the panchayat level to compensate for damages caused by conflicts.
10. Ensure cooperation between panchayats in conflict-affected regions.

**Problem-solving approaches to be adopted by departments to keep wild animals away from agricultural fields and to compensate for damage/losses**

1. Coordinate the activities of various departments related to wildlife conflict in conflict zones under the leadership of the Disaster Management Authority.
2. Seek problem-solving methods in conflict-affected regions with the help of scientific and modern technologies.
3. Organize awareness classes and programs regarding leadership responsibilities.
4. Make rehabilitation schemes attractive.
5. Increase the compensation amount and simplify its procedural formalities. Review compensation guidelines periodically and introduce necessary changes.
6. Formulate adequate insurance schemes for people's property, life, and agricultural crops.
7. Formulate schemes in a manner that ensures full protection/support for the families of those who lose their lives.
8. Ensure the presence of police in conflict zones. Make their services available by providing special training to the armed police to handle human-wildlife conflicts.
9. Encourage the installation of electric fences and trenches by private individuals by providing subsidies.

**Biological Invasion and One Health**

Invasive species are living organisms that are introduced from one region to another and cause economic or ecological problems in the introduced region or pose a threat to the health of other living beings, including humans. When such invasive species reach a new place, they escape from the pathogens and parasites that used to control them in their native habitat.

They do not face natural enemies in the new location. Because of this, their population increases beyond control, leading to various ecological and economic problems. There are many such species that cause health issues.

A key point to understand is that no organism exists as an isolated individual. A multitude of organisms grow inside and outside that living being, much like our own body. Just as lice, mites, and fungi live on the outside of our body, and worms, bacteria, and viruses live inside our body, the body of every organism is a collective entity. When an organism reaches a new place, numerous microorganisms arrive along with it. An example is the African Snail, which has caused widespread problems in Kerala. It carries numerous worms called nematodes inside it. One among them is the rat lungworm called *Angiostrongylus cantonensis*, which causes disease in humans. Another microscopic organism is *Aelurostrongylus abstrusus*, which causes disease in cats. In addition to this, the African Snail carries various other worms. When we handle these snails with our bare hands, their highly microscopic eggs stick to our hands or enter our bodies along with food, eventually reaching the brain and causing unremitting headaches.

Another recent example is the Red-eared Slider turtle, which has spread widely in Kerala. These turtles, which arouse great curiosity in children, are native to Mexico. Turtles that can fit inside a matchbox are traded. People buy them to rear in aquariums, and later, when they grow large and become difficult to handle, they discard them outside. They carry bacteria like *Salmonella* and *Shigella*, which directly cause illness in humans, along with various viruses. These turtles multiply very rapidly. It must be recognized that whenever an invasive species arrives, numerous other organisms come along with it. One must understand that they are highly capable of directly causing health issues.

Along with this, many invasive plants have also reached our land in various ways. Based on a study by the Kerala Forest Research Institute, around 82 species of terrestrial invasive plants have been identified. Even when we celebrate Kerala as a land of lush greenery, invasive plants hold a major share of that greenery today.

In recent times, a plant called the Singapore Daisy has spread extensively across all our countryside. A plant that arrived earlier in this manner is the 'Communist Pacha' (*Chromolaena odorata*). Later came plants like *Lantana camara*, known locally as Arippoopoovu or Kongini. This was followed by 'Dhritharashtra Pacha' (*Mikania micrantha*) and 'Thottavadi' (*Mimosa pudica*). In this manner, a large number of plants have reached our land from other places.

One of the two major problems caused by this at the local level is that invasive species become the cause for the spread of microorganisms/parasites that induce illnesses in humans and other living beings.

Another issue is that these species are encroaching upon the areas where our native local plants, which were used for medicines and other purposes, used to grow. Because of this, most of the plants used for home remedies which were our first line of defence against illnesses are unavailable today. The plots and compounds surrounding our houses are completely filled with such invasive plants. These two major problems that we face today must be overcome first. The Nodal Centre for Biological Invasions (NCBI), functioning at KFRI (Kerala Forest Research Institute), has been carrying out such activities. NCBI identifies new invasive species and spearheads control operations against them.

To eradicate invasive plants, merely uprooting them from the places where they exist is not enough. Native plants must be planted in these areas, and activities to cultivate and nurture them must be implemented vigorously. Only then will we be able to reclaim that ecosystem; otherwise, there is a possibility that invasive plants will encroach upon these regions all over again.

We should be able to document all living organisms, including the invasive species found in that locality, in the People's Biodiversity Registers (PBR) at our panchayat level. Following this, appropriate control measures must be adopted for each type of organism. All kinds of assistance and cooperation from the Nodal Centre for Biological Invasions can be expected for such activities.

## **Irrigation Department**

### **Water Conservation and Irrigation**

Water is the basis of life. Without water, no living organism can survive. We live in an age where water is turning into a commercial commodity. It is of paramount importance to conserve

this rare asset handed down to us as a heritage, use it only as needed, and pass it on to the next generation without polluting or misusing it.

To sensitize the global population to the importance of water conservation and water cooperation, and to strengthen water conservation activities, the year 2013 was observed as the International Year of Water Cooperation following a call by the United Nations.

### **Importance of water sources**

- Under the control of the Irrigation Department in Kerala, there are 16 dams, 44 rivers, and numerous backwaters, ponds, and streams.
- Conserving these water sources is indispensable for the healthy survival of society.

### **Characteristics of water**

- After air, water is the second most vital element necessary to sustain life for humans and other living beings.
- It is rain that ensures water availability on earth. Rain occurs continuously through the water cycle.
- Water received on earth from rain moves rapidly over the surface (up to 3 meters per second) and slowly underground (taking up to 3 days to travel 1 meter).
- Groundwater moves slowly through the layers of rocks and soil. Such layers are called aquifers.
- Water keeps descending in its journey. It joins the groundwater table.
- Water availability is a factor that influences the journey and collection of water, depending on the structure of the soil, topography, and land use.
- The main part of a water source is groundwater. It is replenished again by rainwater. Over-pumping will cause the water table in nearby areas to drop and wells to dry up.
- In coastal areas, if the groundwater table drops below its natural level, saltwater will intrude, turning the remaining water salty.
- Once groundwater is polluted, it is not easy to purify it.

### **Water – some Facts**

- 71% of the Earth's surface is water.
- 97.5% of the available water is saltwater. (The remaining 1.78% exists as ice sheets and groundwater).
- Only 0.3% of the remaining 2.5% can be used by living organisms.
- The world population increases by 85 million every year. Accordingly, the requirement for water is also increasing.
- One-fifth of the water used in the world is obtained from groundwater sources.

- In Kerala, which receives more than 3000 mm of rainfall, droughts and drinking water shortages occur. (Due to fewer rainy days and sloped terrain, water reaches the sea very quickly.)

### **Rain – the only source**

- Rain is the primary source that ensures water availability on earth. Rain happens continuously through the water cycle.
- Efforts must be made to increase the availability of rain by conserving forests and sacred groves (*kavukal*) and planting trees. Steps must be taken to ensure the conservation of rainwater that percolates into the soil and to prevent all water from draining away into the sea.
- Water bodies, wetlands, and paddy fields must be conserved, expanded, and more water must be retained through conservation.
- Without leveling hills, and without filling up paddy fields, wetlands, and water bodies, and without destroying rivers through sand mining, surface and groundwater sources must be strengthened.
- The Southwest Monsoon and the Northeast Monsoon enrich Kerala with rainwater. Yet, we have to experience water scarcity. If water scarcity is to turn into water abundance, the water received must be harvested and retained.

### **For Bathing and Drinking**

- Each person needs up to 3 to 5 liters of water a day for drinking. In addition, 20 liters are needed to cook food, 40–60 liters to wash clothes, and 50 liters of water are needed for bathing.
- Although a maximum of 5 liters of water is enough for a person to drink, 2000–5000 liters of water will be required to produce the food needed by that person for a day.
- If a maximum of 50 liters of water a day is sufficient for a person in a village, it is up to 500 liters in a city. Urban residents use more water and pollute water to a greater extent.
- The water used and consumed by a wealthy person is a hundred times more than what an average citizen uses. The luxury expenditure of water in a five-star hotel is 250 times higher compared to other hotels. A person there wastes 1000 to 1500 liters of water a day.

### **Flood control and regulating water levels**

- Regulating water levels in dams to avoid floods during the monsoon season, providing timely warnings, and cleaning rivers and streams are the primary operations of the department.
- Cleaning before the monsoon: By conducting cleaning activities in rivers and streams for flood control, the risk of flooding is reduced.

### **Hazardous impacts on water sources and control**

- Waste dumping in water sources: Dumping waste into water sources creates major hazards. The incident where a sanitation worker drowned while cleaning the Amayizhanjan canal was a subject of major controversy. This highlights the hazards of waste dumping and how it poses a threat to life.
- Waste dumping control: Since dumping waste into water sources poses a threat to health, strict regulations must be implemented.

### **Water Pollution**

Wastes often flow into our backwaters, rivers, and nearby wells. Soil particles and wastes suspended in water block the sunlight entering the water body. Following this, the photosynthesis of aquatic plants and algae decreases. As a result, aquatic organisms gradually perish over time.

Rock dust from quarries, debris from crushing units, household wastes constantly dumped by people, and waste packed in plastic sacks dumped into water bodies present an active threat. Debris generated as a result of other construction activities also pollutes water.

Chemical fertilizers, pesticides, etc., reach the water directly or indirectly, endangering aquatic life and other organisms that use the water.

Effluents, alkalis, oils, grease, and organic residues flow heavily from industrial factories into rivers, backwaters, and streams, leading to large-scale water pollution.

In addition to these, a most severe water pollution problem experienced by Kerala today is the pollution of drinking water wells from septic tanks. The primary reason for this is the construction of septic tanks without scientific systems.

A very important concept needs to emerge in Kerala regarding this matter. The operation of a biogas-linked community septic tank system in places where 20–25 families reside should become a topic of active discussion. Similarly, every household must use septic tanks equipped with leach pits. Along with implementing these two methods, waterborne diseases currently faced by Kerala (Hepatitis-A, Typhoid, diarrheal diseases) can be effectively controlled, and water pollution can be reduced.

Use water that has been chlorinated within a specified timeframe at home. Cultivating habits such as drinking boiled water and maintaining personal hygiene is essential to prevent health problems caused by water pollution.

## **Well Chlorination**

The cause of waterborne diseases we face is contaminated drinking water. Therefore, it is indispensable to chlorinate drinking water wells, which most people rely on, once every 15 days. The amount of bleaching powder (in grams) required for super-chlorination =  $\pi r^2 h \times 4$ ,

D radius of the well, ( $r = D/2$ ), h = height of water in the well (in meters).

For normal chlorination, the required bleaching powder (in grams) =  $\pi r^2 h \times 2.5$

## **Method of Chlorination**

Draw a bucket of water from the well and pour it into a clean container. Then, dissolve the measured bleaching powder thoroughly in it. After letting it dissolve completely, take only the clear supernatant liquid, leaving the sediment behind, pour it into the bucket, lower it into the well, lower it at least 3 feet into the water, and draw it upward. Repeat this process four or five times. Afterwards, the bucket can be pulled out of the well. Water should not be drawn from the well for about one hour after this. With this, it can be said that the well water is purified to an extent.

If a platform is prepared around the well to prevent rainwater from pooling, and a proper lining is installed to block runoff water, your well can be said to be 90% clean. Even then, only boiled water should be used for drinking.

## **Waterborne Diseases**

- Pollution of water sources: Pollution of water sources paves the way for waterborne diseases. It is highly essential to manage waste properly right from the source.
- Poultry farms, factories, slaughterhouses: It is important to control pollution coming from facilities operating near water sources.

## **Awareness and the role of students**

- Awareness for students: It is essential to provide awareness to students from the primary level onward on topics such as the conservation of water sources and waste management.
- Coordinated action.
- Coordination with other departments: It is suggested to work in tandem with the Irrigation Department, Health Department, Environment Department, and Agriculture Department.

## **Standards for water in water sources as prescribed by the world health organization**

We do not use water that has an unpleasant taste or foul odour for drinking or for cleaning utensils. This applies even if there is an aesthetic preference; however, this water is a threat to other living organisms that depend on it.

## Drinking Water Standards as per Indian Standard (BIS Drinking Water Specification)

| Organoleptic & Physical Parameters<br>(Foreword and Clause 4) |                                                   |                                      |                                                                  |                                             |                                                                                                                                                                      |
|---------------------------------------------------------------|---------------------------------------------------|--------------------------------------|------------------------------------------------------------------|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                               | Characteristic                                    | Requirement<br>(Acceptable<br>Limit) | Permissible<br>Limit in the<br>Absence of<br>Alternate<br>Source | Method of Test,<br>ref to I .S 3025<br>part | Remarks                                                                                                                                                              |
| (1)                                                           | (2)                                               | (3)                                  | (4)                                                              | (5)                                         | (6)                                                                                                                                                                  |
| (i)                                                           | Colour, Hazen<br>units, Max                       | 5                                    | 15                                                               | Part 4                                      | In the<br>absence<br>of an<br>alternate<br>source,<br>this can<br>be<br>extended<br>up to 15,<br>provided<br>there is no<br>suspicion<br>of toxic<br>substance<br>s. |
| (ii)                                                          | Odour                                             | Agreeable                            | Agreeable                                                        | Part 5                                      | a) Test<br>when cold<br>and after<br>heating.<br><br>b) Test at<br>various<br>dilutions.                                                                             |
| (iii)                                                         | pH Value                                          | 6.5–8.5                              | No relaxation<br>anywhere                                        | Part 11                                     | -----                                                                                                                                                                |
| (iv)                                                          | Taste                                             | Agreeable                            | Agreeable                                                        | Part 7 and 8                                | Testing<br>should be<br>conducted<br>only<br>after<br>ensuring<br>safety.                                                                                            |
| (v)                                                           | Turbidity, NTU,<br>Max                            | 1                                    | 5                                                                | Part 10                                     | -----                                                                                                                                                                |
| (vi)                                                          | Total Dissolved<br>Solids (TDS),<br>mg/litre, Max | 500                                  | 2000                                                             | Part 16                                     | -----                                                                                                                                                                |

## General Parameters Concerning Substances Undesirable in Excessive Amounts

(Foreword and Clause 4)

| Sl.no  | Characteristic                                          | Requirement (Acceptable Limit) | Permissible Limit in the Absence of Alternate Source | Method of Test, ref to I.S 3025 part           | Remarks |
|--------|---------------------------------------------------------|--------------------------------|------------------------------------------------------|------------------------------------------------|---------|
| (1)    | (2)                                                     | (3)                            | (4)                                                  | (5)                                            | (6)     |
| (I)    | Aluminium<br>(as Al), <i>mg/l</i> , Max                 | 0.03                           | 0.2                                                  | IS 3025<br>(Part 55)                           | -----   |
| (II)   | Ammonia(as total ammonia-N) <i>mg/l</i> , Max           | 0.5                            | No relaxation anywhere                               | IS 3025<br>(Part 34)                           | -----   |
| (III)  | Anionic Detergents<br>(as MBAS)<br><i>mg/l</i> , Max    | 0.2                            | 1.0                                                  | Annex K<br>of IS 13428 or<br>IS 15302          | -----   |
| (IV)   | Barium<br>(as Ba), <i>mg/l</i> , Max                    | 0.7                            | No relaxation anywhere                               | Annex F<br>of IS 13428 *                       | -----   |
| (V)    | Boron(as B),<br><i>mg/l</i> , Max                       | 0.5                            | 1.0                                                  | or IS 15302                                    | -----   |
| (VI)   | Calcium(as Ca), <i>mg/l</i> , Max                       | 75                             | 200                                                  | IS 3025<br>(Part 40)                           | -----   |
| (VII)  | Chloramines<br>(as Cl <sub>2</sub> ), <i>mg/l</i> , Max | 4.0                            | No relaxation anywhere                               | IS 3025<br><br>(Part 26)* or<br>APHA 4500-Cl G | -----   |
| (VIII) | Chloride                                                | 250                            | 1000                                                 | or APHA<br>4500-Cl G                           | -----   |

|        |                                                |     |                           |                      |                                                                                                                                                                                                                                      |
|--------|------------------------------------------------|-----|---------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | (as Cl), <i>mg/l</i> ,<br>Max                  |     |                           |                      |                                                                                                                                                                                                                                      |
| (IX)   | Copper<br>(as Cu), <i>mg/l</i> ,<br>Max        | 0.5 | 0.5                       | or APHA<br>4500-Cl G | -----                                                                                                                                                                                                                                |
| (X)    | Fluoride(as F),<br><i>mg/l</i> , Max           | 1.0 | 1.5                       | or APHA<br>4500-Cl G | -----                                                                                                                                                                                                                                |
| (XI)   | Free Residual<br>Chlorine<br><i>mg/l</i> , Min | 0.2 | 1                         | or APHA<br>4500-Cl G | This condition is applicable only for water that has been chlorinated. Testing should be conducted at the consumer's end. When protection against viral diseases is required, the minimum amount of this should be 0.5 <i>mg/l</i> . |
| (XII)  | Iron<br>(as Fe), <i>mg/l</i> ,<br>Max          | 0.3 | No relaxation<br>anywhere | IS 3025<br>(Part 53) | The total combined concentration of Manganese (as Mn) and Iron (as Fe) must not exceed 0.3 <i>mg/l</i> .                                                                                                                             |
| (XIII) | Magnesium<br>(as Mg), <i>mg/l</i> ,<br>Max     | 30  | 100                       | IS 3025<br>(Part 46) | -----                                                                                                                                                                                                                                |

|         |                                                                             |       |                        |                                                        |                                                                                                          |
|---------|-----------------------------------------------------------------------------|-------|------------------------|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| (XIV)   | Manganese<br><br>(as Mn), <i>mg/l</i> ,<br>Max                              | 0.1   | 0.3                    | IS 3025<br><br>(Part 59)                               | The total combined concentration of Manganese (as Mn) and Iron (as Fe) must not exceed 0.3 <i>mg/l</i> . |
| (XV)    | Mineral Oil<br><br><i>mg/l</i> , Max                                        | 0.5   | No relaxation anywhere | Clause 6 of IS3025 (part 39 Infrared partition method) | -----                                                                                                    |
| (XVI)   | Nitrate (as NO <sub>3</sub> ), <i>mg/l</i> , Max                            | 45    | No relaxation anywhere | IS 3025 (Part 34)                                      | -----                                                                                                    |
| (XVII)  | Phenolic Compounds (as C <sub>6</sub> H <sub>5</sub> OH), <i>mg/l</i> , Max | 0.001 | 0.002                  | IS 3025 (Part 43)                                      | -----                                                                                                    |
| (XVIII) | Selenium (as Se), <i>mg/l</i> , Max                                         | 0.01  | No relaxation anywhere | IS 3025(Part 56) or IS 3025                            | -----                                                                                                    |
| (XIX)   | Silver<br><br>(as Ag), <i>mg/l</i> , Max                                    | 0.01  | No relaxation anywhere | Annex J of IS 13428                                    | -----                                                                                                    |
| (XX)    | Sulphate (as SO <sub>4</sub> ), <i>mg/l</i> , Max                           | 200   | 400                    | IS 3025(Part 24)                                       | This can be extended up to 400 provided Magnesium does not exceed 30.                                    |
| (XXI)   | Sulphide(as H <sub>2</sub> S), <i>mg/l</i> , Max                            | 0.05  | No relaxation anywhere | IS 3025(Part 29)                                       | -----                                                                                                    |

|             |                                                                  |     |     |                  |       |
|-------------|------------------------------------------------------------------|-----|-----|------------------|-------|
| (XXII<br>)  | Calcium<br>Carbonate<br><br>(as $CaCO_3$ ),<br><i>mg/l</i> , Max | 200 | 600 | IS 3025(Part 23) | ----- |
| (XXII<br>I) | Total<br>Hardness(as<br>$CaCO_3$ ), <i>mg/l</i> ,<br>Max         | 200 | 600 | IS 3025(Part 21) | ----- |
| (XXI<br>V)  | Zinc(as Zn),<br><i>mg/l</i> , Max                                | 5   | 15  | IS 3025(Part 49) | ----- |

| Parameters Concerning Toxic Substances |                                                             |                               |                                                      |                                      |              |
|----------------------------------------|-------------------------------------------------------------|-------------------------------|------------------------------------------------------|--------------------------------------|--------------|
| (Foreword and Clause 4)                |                                                             |                               |                                                      |                                      |              |
| Sl.no.                                 | Characteristic                                              | Requirement(Acceptable Limit) | Permissible limit in the absence of alternate source | Method of Test, ref to I.S 3025 part | Remarks      |
| (1)                                    | (2)                                                         | (3)                           | (4)                                                  | (5)                                  | (6)          |
| (I)                                    | Cadmium (as Cd), mg/l, Max                                  | 0.003                         | No relaxation                                        | IS 3025(Part 41)                     | -----        |
| (II)                                   | Cyanide (as CN), mg/l, Max                                  | 0.005                         | No relaxation                                        | IS 3025(Part 27)                     | -----        |
| (III)                                  | Lead (as Pb), mg/l, Max                                     | 0.01                          | No relaxation                                        | IS 3025(Part 47)                     | 0.01         |
| (IV)                                   | Mercury (as Hg),mg/l, Max                                   | 0.001                         | No relaxation                                        | IS 3025(Part 48)                     | -----        |
| (V)                                    | Molybdenum (as Mo),mg/l, Max                                | -----                         | -----                                                | Mercury analyser                     | -----        |
| (VII)                                  | Pesticides,µg/l, Max<br>Polychlorinated biphenyls,mg/l, Max | 0.2                           | No relaxation                                        | IS 3025 (Part 54)                    | -----        |
| (VII I)                                | Polycyclic Aromatic Hydro-                                  | See Table 5                   | No relaxation                                        | See Table 5                          | -----        |
| (IX)                                   | Carbons(as PAH), mg/l,Max                                   | 0.0005                        | No relaxation                                        | ASTM 5175                            | -----        |
| (X)                                    | Total Arsenic(as such), mg/l,Max                            | -----                         | -----                                                | -----                                | or APHA 6630 |
| (XI)                                   | Total Chromium(as Cr), mg/l, Max                            | 0.0001                        | No relaxation                                        | APHA 6440                            | -----        |

|         |                                               |       |               |                      |       |
|---------|-----------------------------------------------|-------|---------------|----------------------|-------|
| (XII)   | Trihalomethanes                               | ----- | -----         | -----                | ----- |
| (XII I) | a) Bromoform, <i>mg/l</i> , Max               | 0.01  | 0.05          | IS 3025<br>(Part 37) | ---   |
| (XI V)  | b)Dibromochloromethane, <i>mg/l</i> , Max     | 0.05  | No relaxation | IS 3025<br>(Part 52) | ---   |
| (XI V)  | b) Dibromochloromethane,<br><i>mg/l</i> , Max | 0.05  | No relaxation | IS 3025<br>(Part 52) | ---   |
| (XV )   | c) Bromodichloromethane, <i>mg/l</i> , Max    | ---   | ---           | ---                  | ---   |
| (XV I)  | d) Chloroform, <i>mg/l</i> , Max              | 0.1   | No relaxation | ASTM D<br>3973-85*   | ---   |

| Parameters Concerning Radioactive Substances |                                     |                               |                                                      |                                       |         |
|----------------------------------------------|-------------------------------------|-------------------------------|------------------------------------------------------|---------------------------------------|---------|
| (Foreword and Clause 4)                      |                                     |                               |                                                      |                                       |         |
| Sl No                                        | Characteristic                      | Requirement(Acceptable Limit) | Permissible limit in the absence of alternate source | Method of Test, ref to I .S 3025 part | Remarks |
| (1)                                          | (2)                                 | (3)                           | (4)                                                  | (5)                                   | (6)     |
| (I) Radioactive Substances:                  |                                     |                               |                                                      |                                       |         |
|                                              | a) Alpha emitters <i>Bq/l</i> , Max | 0.01                          | No relaxation                                        | (Part 2)                              | -----   |
|                                              | b) Beta emitters, <i>Bq/l</i> , Max | 0.01                          | No relaxation                                        | IS 3025(Part 47)                      | -----   |

## Pesticide Residue Limits and Testing methods

### (Foreword and Clause 4)

| SI No   | Pesticide                              | Limit<br>µg/l | Test Methods, Reference |             |
|---------|----------------------------------------|---------------|-------------------------|-------------|
|         |                                        |               | USEPA                   | AOAC/ISO    |
| (1)     | (2)                                    | (3)           | (4)                     | (5)         |
| (I)     | Alachlor                               | 20            | 525.2, 507              | -----       |
| (II)    | Atrazine                               | 2             | 525.2, 8141<br>A        | -----       |
| (III)   | Aldrin / Dieldrin                      | 0.03          | 508                     | -----       |
| (IV)    | Alpha HCH                              | 0.01          | 508                     | -----       |
| (V)     | Beta HCH                               | 0.04          | 508                     | -----       |
| (VI)    | Butachlor                              | 125           | 525.2, 8141<br>A        | -----       |
| (VII)   | Chlorpyrifos                           | 30            | 525.2, 8141<br>A        | -----       |
| (VIII)  | Delta HCH                              | 0.04          | 508                     | -----       |
| (IX)    | 2,4-Dichlorophenoxyacetic Acid         | 30            | 515.1                   | -----       |
| (X)     | DDT (Isomers of O,P,P,P-DDT, DDE, DDD) | 1             | 508                     | AOAC 990.06 |
| (XI)    | Endosulfan (alpha, beta, sulphate)     | 0.4           | 508                     | AOAC 990.06 |
| (XII)   | Ethion                                 | 3             | 1657 A                  | ---         |
| (XIII)  | Gamma - HCH (Lindane)                  | 2             | 508                     | AOAC 990.06 |
| (XIV)   | Isoproturon                            | 9             | 532                     | ---         |
| (XV)    | Malathion                              | 190           | 8141 A                  | ---         |
| (XVI)   | Methyl Parathion                       | 0.3           | 8141 A                  | ISO 10695   |
| (XVII)  | Monocrotophos                          | 1             | 8141 A                  | ---         |
| (XVIII) | Phorate                                | 2             | 8141 A                  | ---         |



## **Drugs Control Department**

Antimicrobials are medicines used to prevent and treat various infections. According to the definition by the World Health Organization, antibiotics are medicines used to prevent and treat infections caused by bacteria. Medicines worth approximately 10,000 crore rupees are marketed in the state every year. Their manufacturing and marketing are regulated through the Drugs and Cosmetics Act and its subsequent rules. It is estimated that there is a rapid increase in the use of antimicrobial medicines in the healthcare sector. Antimicrobial Resistance (AMR) is a phenomenon that occurs when microorganisms—such as bacteria, viruses, fungi, and parasites—acquire resistance against the medicines used to cure the infections they cause, thereby rendering the medicines ineffective.

The unscientific and unregulated use of antibiotics is one of the major causes driving society toward antimicrobial resistance. Selling antibiotics without a doctor's prescription is a violation of the law. Buying antibiotics in this manner and using them for self-treatment leads to antimicrobial resistance.

There is a high possibility of misuse regarding expired and unusable medicines, as well as improperly disposed medicines. Furthermore, their unscientific disposal can pose a serious threat even to our ecosystem. It has been found that irresponsibly discarding expired and unusable medicines into the environment, and indiscriminately dumping them into the soil and water bodies, is one of the primary causes of antimicrobial resistance. However, the reality is that there are currently no laws or systems in place to collect or scientifically process used, unusable, or expired medicines. It is expected that an amendment to the law regarding the scientific disposal of these items will come into effect in the near future. Since there are no systems to retrieve or scientifically process such medicines (including tablets, capsules, ointments, liquid medicines, empty strips, etc.), a situation arises where they are carelessly discarded in backyards, agricultural fields, roads, and water bodies. If we overlook this critical situation—where medicines, including highly potent chemical-laden antibiotics, dissolve into the soil and water and re-enter the human body through food items, fish, and animals—we will arrive at a catastrophic state of Antimicrobial Resistance (AMR) that paves the way for the destruction of humanity, the environment, fish and animal resources. The Drugs Control Department is implementing various action plans to effectively combat this silent pandemic, which poses a global health threat.

## **Fisheries**

Fisheries is a rapidly growing sector aimed at meeting the rising global demand for food items containing flesh (protein). Compared to other protein-containing food sources, fish is a highly cost-effective and safe food source. The flesh of healthy fish is mostly free of microbes. However, due to unscientific farming practices, and unscientific methods in fish processing, distribution, and marketing, as well as environmental pollution, there is a possibility of food contamination and diseases. Therefore, when considering the growing global population and the demand for fish products, the need for a proper assessment of food safety issues and appropriate legislation becomes evident.

Issues in the production sector: Chemicals, plastics, heavy metals, antibiotics, etc.

Issues in the distribution sector: Marketing of stale fish, food preservation using chemicals, etc.

Today, many people raise various types of fish in aquariums and tanks for curiosity and recreation. Like all other animals, fish can also carry pathogens that cause diseases in humans. These microbes can contaminate the fish as well as the water they live in. By ensuring proper maintenance of the fish and the aquariums where they are kept, and by applying some simple tricks, we can reduce the likelihood of contracting diseases. *Aeromonas* is a type of bacteria commonly found in freshwater tanks and aquariums. This bacteria causes disease in fish and amphibians. *Aeromonas* causes discoloration in the limbs of amphibians and the fins of fish, and in aquatic organisms, it causes internal bleeding. These pathogens reach humans through open wounds or by drinking contaminated water. Infections usually occur in young children and older adults with low immunity. This can result in diarrhea or blood infections. Ensuring the water quality in aquariums, immediately removing dead fish, and practicing healthy habits, including washing hands, will reduce the possibility of *Aeromonas* infection.

### **1. Zoonotic Diseases**

Waterborne and fish-borne diseases have created significant problems globally in the aquaculture and fishing industries. In particular, zoonotic diseases pose a widespread threat to humans. The primary causes of zoonotic diseases are bacteria, parasites, viruses, fungi, etc. *Mycobacterium*, *Erysipelothrix*, *Campylobacter*, *Aeromonas*, *Vibrio*, *Edwardsiella*, *Escherichia*, *Salmonella*, *Klebsiella*, *Streptococcus* are the bacteria's that cause diseases in fish. Often, these infections do not result in a severe disease state in the fish itself, but they can cause serious illness in humans. The probability of contracting the disease is higher in people with chronic illnesses, reduced immunity, infants, pregnant women, and the elderly. Therefore, individuals belonging to these categories must seek advice from experts before handling or rearing aquatic organisms, and they must strictly follow their instructions.

The general symptoms of various bacterial diseases in fish are similar. There is no significant change in the symptoms depending on the type of bacteria. Loss of appetite, lethargy, ulcers or redness/bleeding on the body, loose or missing scales, abnormal swimming behaviour, and eye

swelling are the common symptoms of bacterial diseases. Careful examination and precise sample collection are necessary to identify which type of bacteria is causing the illness. Some fish may become disease carriers without displaying any symptoms. For this reason, accurate testing is essential.

Various species of *Mycobacterium*, such as *Mycobacterium marinum*, *M. fortuitum*, and *M. chelonae*, are found in fish. All fish are constantly in contact with various types of pathogens. Even if symptoms are not visible in these fish, they can be disease carriers. These diseases can be transmitted to humans through direct contact with fish (whether alive or dead) or through contaminated water in ponds and aquariums. The bacteria can enter the body through cuts or wounds on their skin.

Mycobacteriosis is a disease caused by *Mycobacterium*. People affected by mycobacteriosis typically develop ulcers on the skin of their hands. This condition is referred to as "fish tank granuloma." Individuals with low immunity have a risk of developing lymphadenitis (swelling of the lymph nodes) similar to tuberculosis. Additionally, there is a risk of developing other serious respiratory diseases.

*Streptococcus iniae* is a type of Gram-positive bacteria found in both freshwater and marine organisms. There is a possibility for this bacteria to reach humans when handling fish, whether alive or dead. The transmission of the disease to humans occurs through cuts or bruises on the body. In humans, these cause diseases such as cellulitis, arthritis, endocarditis, and meningitis. In severe cases of infection, death may even occur.

*Erysipelothrix rhusiopathiae* is a pathogen commonly found in soil and water. The disease spreads to humans through cuts or bruises on the body. Erysipeloid is a disease caused by *Erysipelothrix rhusiopathiae*. An infection occurring on the skin is the primary symptom of this disease. If it becomes severe, the infection can extend even to the coronary arteries or the heart.

*Campylobacter*, *Aeromonas*, *Vibrio*, *Edwardsiella*, *Escherichia*, *Salmonella*, and *Klebsiella* are other pathogens. They can spread through wounds, or by consuming contaminated water, food, or other substances. *Aeromonas* is mostly found in freshwater organisms, while *Vibrio* is mostly found in marine organisms. If these pathogens enter the body, they will cause vomiting, diarrhea, and other severe digestive system disorders. In individuals with low immunity, it can even lead to loss of life. Therefore, any person with open wounds or cuts should avoid directly handling fish or immersing injured skin in water. While cleaning aquariums, one must wear gloves and follow other safety standards.

A large number of parasitic organisms live in aquatic animals. This includes parasites living on the outside of the fish's body (ectoparasites) and parasites living inside the fish's body (endoparasites). Consuming fish dishes that are not properly cooked allows these parasites to reach humans and cause disease. Therefore, fish dishes should only be consumed after being properly cooked.

## **2. Antimicrobial Resistance (AMR)**

Antimicrobial Resistance (AMR) is a major health problem facing the world today. Antimicrobial Resistance (AMR) is a condition where the internal structure of bacteria, viruses, fungi, and parasites changes over time, causing them to stop responding to medicines. This can happen naturally in bacteria through genetic mutation or random biological evolution. Additionally, it can occur through the genetic transfer of resistance genes. Due to the uncontrolled use of antibiotics, mutations (biological changes) occur in bacteria that can render the antibiotics ineffective. Consequently, antibiotics become ineffective against the bacteria. By the year 2050, the death rate due to antimicrobial resistance is projected to be higher than that of accidental deaths.

The emergence and spread of antibiotic-resistant pathogens pose a significant threat to human health. The main causes of this trend include the absence of precise and stringent laws, lapses in law enforcement, lack of oversight, and the unscientific and uncontrolled use of medicines. It is predicted that by 2050, 4.7 million human lives will be lost due to AMR in the Asian continent. India is one of the countries with the highest rates of antimicrobial resistance in the world.

AMR against 17 types of antibiotics has been reported from sample tests conducted in various aquaculture farms across South-East Asian countries. Similar testing has been conducted in Kerala by collecting samples from water bodies outside of hospital waste zones. The testing revealed the presence of bacterial strains with resistance to more than one medicine (multi-drug resistance). All of these are bacteria capable of causing illness in humans. This test result is alarming.

### **3) Foodborne Diseases**

#### **Pathogens Transmitted Through Food**

A lot of microorganisms that are human pathogens are found all around us. Therefore, the likelihood of contamination is higher when food is being cooked or handled. Consuming contaminated food or water leads to food poisoning.

#### **How Food Poisoning Occurs**

Pathogens found in contaminated food or water sometimes produce certain toxins. These toxins cause diseases in the human body. Similarly, pathogenic microorganisms themselves often reach the human body through contaminated food or water. These are also capable of causing diseases.

#### **Examples**

##### **1. Botulism**

**Pathogen: *Clostridium botulinum***

Botulism is a foodborne illness caused by consuming food containing neurotoxins produced by *Clostridium botulinum*. Even if these neurotoxins reach the human body in very small quantities (30-100 ng), they can cause paralysis and death.

### **Symptoms:**

Symptoms appear within 12–36 hours. Nausea, vomiting, vision impairment, loss of normal function of the mouth and throat, lack of muscle coordination, and respiratory failure ultimately lead to death.

## **2. Staphylococcus**

### **Pathogen: Staphylococcus aureus**

Staphylococcal food poisoning is caused by consuming enterotoxins formed in food during the growth of certain specific strains of *Staphylococcus aureus*.

This bacterium is primarily found in parts of the human body such as the throat and nasal passage. Through the unscientific handling of food items, these bacteria mix into the food from the human body and subsequently lead to food poisoning.

## **3. E. coli**

### **Pathogen: E. coli**

*E. coli* is primarily found in the human digestive tract and intestines. These are harmless organisms that assist the digestive system. However, certain strains of *E. coli* can cause illness in humans. There is a risk of food poisoning through contamination of food by *E. coli*. *E. coli*-induced food poisoning frequently originates from fish harvested under unsanitary conditions, or from food items prepared and handled in unhygienic environments.

## **4. Salmonellosis**

Food poisoning caused in the human body by bacteria belonging to the *Salmonella* genus is called Salmonellosis.

The probability of contracting Salmonellosis through fish or other marine organisms is high. Nausea, vomiting, abdominal pain, diarrhea, fever, and headache are the symptoms of this food poisoning. Disease symptoms appear 6–8 hours after consuming contaminated food.

## **5. Listeriosis**

*Listeria monocytogenes* is the most important pathogen responsible for the disease called Listeriosis.

## **6. *Vibrio cholerae***

*Vibrio cholerae* is the organism that causes cholera in humans. Severe diarrhea, abdominal pain, nausea, vomiting, and dehydration are the symptoms of the disease. In severe cases, death may even occur.

## **7. *Vibrio parahaemolyticus***

This bacterium is primarily found in marine organisms. Abdominal pain, diarrhea, nausea, vomiting, mild fever, chills, and headache are the symptoms of the disease.

## **8. *Campylobacter***

It is found in contaminated water, clam meat, etc. Abdominal pain, nausea, vomiting, constipation, diarrhea, headache, and fever are the symptoms of the disease.

## **Marine Toxins**

### **1. Shellfish toxins**

Aquatic microorganisms like dinoflagellates and diatoms produce certain toxins. Molluscs, which are filter feeders, consume these microorganisms and consequently absorb the toxins into their bodies. Consuming marine organisms that have absorbed toxins in this manner transmits this poisoning to humans.

### **2. Ciguatera toxins**

CFP (Ciguatera Fish Poisoning) is caused by consuming various types of tropical and subtropical carnivorous reef fishes such as barracuda, groupers, sea bass, and snappers.

Small herbivorous fish living in coral reefs feed on certain toxic dinoflagellates. When carnivorous fish eat these small fish, the toxins accumulate in their bodies as they grow, and ultimately, it reaches humans.

### **3. Tetrads toxins**

Humans contract this poisoning by consuming puffer fish. This toxin is not found in all puffer fish. Certain bacteria belonging to the *Pseudomonas* genus are found inside the body of puffer fish. Toxins produced by these bacteria cause Tetrads poisoning.

### **4. Scombroid toxins**

Scombroid poisoning, also known as histamine poisoning, is caused by the consumption of fish containing high levels of histamine. Eating scombroid fish with red meat (such as tuna, mackerel, seer fish) can cause scombroid poisoning. This poisoning is mostly found in stale

fish. Certain microorganisms convert histidine, an amino acid present in the body of fish, into histamine. When this enters the human body, it causes poisoning.

### **Environmental Impacts Associated with Fish Farming**

Fish farming has become a major source of global food production. While it helps meet the rising demand for marine products, it also raises several environmental challenges. If not managed properly, aquaculture can lead to ecological imbalance, water pollution, and loss of biodiversity. Understanding these impacts and implementing sustainable practices is crucial to minimizing environmental degradation while maintaining production efficiency.

### **Environmental Impacts of Fish Farming**

- **Water Pollution:** Excessive feed, fish waste, and chemicals used in aquaculture accumulate in water bodies and lead to eutrophication. High nutrient levels cause algal blooms, which deplete oxygen in the water and harm aquatic organisms.
- **Habitat Destruction:** To make space for fish farms, coastal and freshwater ecosystems such as mangroves and wetlands are frequently cleared. The loss of habitat affects biodiversity and disrupts the local ecosystem.
- **Spread of Diseases and Parasites:** High-density fish farms can turn into breeding grounds for diseases and parasites.
- **Use of Antibiotics and Chemicals:** The excessive use of antibiotics and pesticides in aquaculture leads to Antimicrobial Resistance (AMR) and chemical pollution. These chemicals accumulate in residues and affect non-target organisms.
- **Overfishing for Fish Feed:** Many fish farms rely on wild-caught fish to produce feed, which exerts pressure on marine fish stocks. Unsustainable fish feed production disrupts marine food chains.

### **Control Measures**

- **Adopting Sustainable Fish Farming Practices:** Use eco-friendly, nutrient-efficient feeds to reduce pollution. Implement Integrated Multi-Trophic Aquaculture (IMTA) systems where different species (e.g., fish, seaweed, clam meat) are farmed together to recycle nutrients.
- **Proper Waste Management:** Install biofilters before discharging waste into natural water bodies. Regularly monitor water quality parameters such as oxygen levels, pH, and nutrient density.
- **Reducing Dependence on Wild Fish for Feed:** Promote alternative protein sources such as plant-based feeds and insect-based food. Develop sustainable feed formulations using agricultural by-products.
- **Implementing Biosecurity Measures:** Conduct regular health monitoring of farmed fish to prevent disease outbreaks. Use vaccination and probiotics instead of antibiotics to improve fish health.

- **Ecosystem Protection and Restoration:** Avoid developing fish farms in ecologically sensitive areas such as mangroves and coral reefs. Replant mangroves and improve wetland conservation efforts to restore destroyed ecosystems.
- **Strict Regulatory Compliance and Certification:** Encourage fish farms to comply with sustainable certification standards such as the Aquaculture Stewardship Council (ASC) or Global GAP. Strengthen regulations for monitoring and controlling aquaculture practices, including controls on chemical use and waste disposal.

### **Department of Environment and Climate Change**

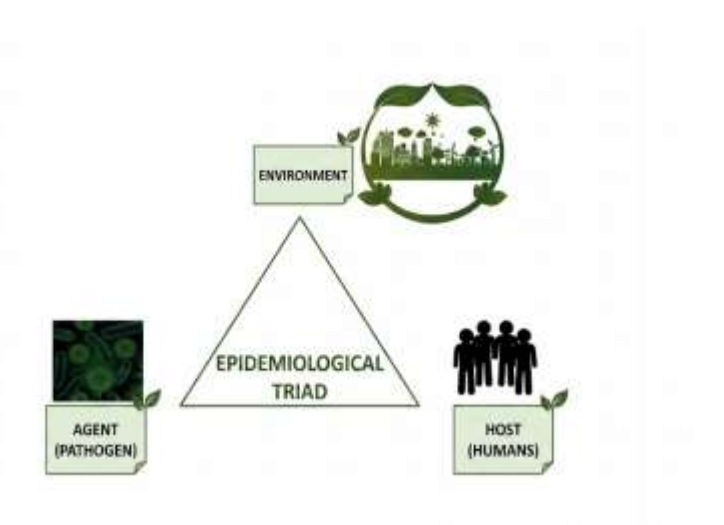
- The law that existed in the country regarding the environment was the Bengal Smoke-Nuisance Act, 1905. The participation of the then Prime Minister in the United Nations Conference on the Human Environment held in Stockholm in June 1972 paved the way for the formulation of a national environmental policy and the formation and implementation of the Water (Prevention and Control of Pollution) Act, 1974, which was the first post-independence law for environmental protection. Through the 42nd Amendment of 1976, these changes became reflected in the Indian Constitution by

adding Articles 48A and 51A(g). Subsequently, by also formulating the Air (Prevention and Control of Pollution) Act, 1981, and the Environment (Protection) Act, 1986, the necessary legal frameworks were made possible to enable environmental management in the country.

## Health and Environment

- The environment is defined as the sum total of all living and non-living components that influence human life, along with their effects. Environment denotes air, water, and atmosphere, as well as the interrelationship among them, and between humans and other living organisms.
- The concept of One Health ensures not only the health of humans, birds, and animals, but also the health of the environment where humans, birds, and animals commonly interact. Rising zoonotic diseases and environmental challenges increase the relevance of the One Health concept in the modern era. Taking into account the rise in diseases affecting animals and other infectious diseases, it can be seen that maximum priority is given to the health of humans and animals when planning projects or programs at global, national, and local levels.

## Relevance of Environment in One Health



In the concept of One Health, the environment is broadly defined. Just like it includes earth, water, atmosphere, and various flora and fauna interacting with each other, it also encompasses natural and man-made habitats. The environment is a factor that directly affects the health of both humans and animals. There are three factors that lead to the spread of disease in humans and animals. These are the disease causes (agents), the environment, and the person affected by the disease (host). Biological and non-biological factors, such as disease-causing organisms and chemical substances that cause diseases, are called agents or causes. The infected

individual is referred to as the second factor: the host. The 'host' factor is related to the individual. Factors including physical structure, immune system, and genetic makeup are included in it.

Since climate change, deforestation, soil erosion, pollution, excessive use of chemical fertilizers in agriculture, inadequate food production, and poverty cause diseases in humans and animals globally, the environment is considered the third factor. Together, these three factors—agent (cause), host and environment—are called the epidemiological triad.

It is when we recognize the importance of water purification to prevent cholera, environmental cleanliness to prevent malaria, and keeping the environment free from waste to prevent rabies caused by stray dogs, that the magnitude of the environment's role in One Health is revealed.

### **Aquatic Environment**

Water is the most abundant and essential substance on the Earth's surface, playing a fundamental role in sustaining life. Approximately 71% of the Earth is covered by water. It is found in oceans, glaciers, lakes, rivers, underground aquifers, and even within the bodies of living organisms. The unparalleled physical and chemical properties of water make it an ideal medium for biochemical activities, which fosters the development of life.

The water cycle ensures the movement of water between the Earth's surface and the atmosphere. However, human activities, climate change, and pollution disrupt this natural cycle, leading to serious challenges such as water scarcity, pollution, and extreme weather phenomena.

### **Availability of Fresh Water**

Despite the abundance of water on Earth, only 2.5% of it is fresh water, and only a small fraction of that is accessible for human use. Due to population growth, agriculture, and industrialization, the growing demand for water is weakening fresh water sources. Factors like the overexploitation of groundwater, deforestation, and inefficient water management worsen the situation. Climate change also plays a major role, altering rainfall patterns and causing issues like droughts and floods.

Since safe drinking water is not easily available in many regions, people are forced to rely on polluted or unsafe sources. To ensure future water availability, water conservation strategies, rainwater harvesting, and efficient irrigation methods are crucial.

### **Pollution of Water Sources**

Water pollution is a major threat to the availability of fresh water. Various human activities contribute to the pollution of water bodies:

- **Industrial Pollution:** Factories discharge harmful chemicals, heavy metals, and untreated wastewater into rivers and lakes.

- **Agricultural Waste:** The excessive use of chemical fertilizers and pesticides, along with the runoff of animal waste, leads to the contamination of both groundwater and surface water.
- **Domestic Waste:** The improper disposal of wastewater, plastic waste, and household chemicals degrades the quality of water.
- **Oil Spills and Marine Pollution:** Oil leaking from tankers and the dumping or abandoning of plastic waste into oceans put marine ecosystems in danger.

Contaminated water sources become unsafe for human daily use, as well as for agriculture and aquatic life, leading to serious health problems and environmental degradation.

### **Floods and Droughts**

Due to climate change and deforestation, extreme weather events such as floods and droughts are becoming frequent. Excessive rainfall or poor drainage systems cause water bodies, including rivers and lakes, to overflow. Urbanization and encroachment on natural waterways worsen the situation. This leads to loss of life, destruction of property, and contamination of drinking water. Drought causes prolonged water scarcity, meaning a shortage of water for drinking, agriculture, and industrial needs. This leads to crop failure, food scarcity, and economic distress in the affected areas.

Sustainable water management practices such as afforestation, watershed conservation, and improved irrigation technologies are essential to mitigate these disasters.

### **Waterborne Diseases**

Contaminated water acts as a breeding ground for numerous pathogens, leading to waterborne diseases that affect millions of people worldwide. Common waterborne diseases include:

- **Cholera:** Caused by the *Vibrio cholerae* bacteria. It causes severe diarrhea and dehydration.
- **Typhoid:** A bacterial infection transmitted through contaminated drinking water. It causes high fever and weakness.
- **Diarrhea/Vomiting:** A condition caused by bacteria or parasites.
- **Hepatitis A & E:** Viral infections transmitted through unsafe drinking water.
- **Leptospirosis:** Transmitted through water contaminated with animal urine. It affects the liver and kidneys.

Improving sanitation, proper waste disposal, and providing clean drinking water are crucial in preventing these diseases.

## **Diseases through the Food chain**

Contaminated water not only affects drinking water sources but also enters the food chain, which causes serious health consequences:

**Bioaccumulation of Heavy Metals -**

Industrial wastes containing mercury, lead, and arsenic contaminate water bodies. These toxic substances enter fish and marine resources, eventually reaching humans and causing neurological and organ damage.

**Pesticides -** Agricultural chemicals enter the water supply and are absorbed by crops, causing long-term health problems such as cancer and hormonal imbalances.

**Bacteria & Parasitic Infections -** Contaminated water used for irrigation or food processing introduces pathogens into vegetables, fruits, and dairy products, leading to digestive tract diseases.

To reduce these risk factors, strict pollution control measures, regular food safety monitoring, and sustainable agricultural practices are essential.

## **Air Environment**

The Earth's atmosphere is a complex system composed of gases and suspended particles; it sustains life and regulates the climate. It acts as a protective shield against harmful solar radiation and supports climate and ecological processes. However, human activities have significantly altered air quality, leading to pollution, climate change, and health problems.

### **Pure Air**

Pure air is essential for sustaining life and maintaining ecological balance. It primarily consists of Nitrogen (78%), Oxygen (21%), Argon (0.93%), Carbon dioxide (0.04%), trace elements, and water vapor. Pure air plays a crucial role in respiration, climate patterns, and climate regulation. The presence of natural particles such as pollen and sea salt is minimal in pure air, which ensures a stable and healthy atmosphere.

## **Air Pollution**

Air pollution refers to the presence of harmful substances, including gases, particulates, and biological molecules, that pose a threat to human health and the environment. The main sources are:

**Natural Sources:** Volcanic eruptions, wildfires, dust storms.

**Man-made Sources:** Industrial emissions, vehicle emissions, deforestation, burning of fossil fuels.

**Air pollution is of two types:**

1. **Primary Pollutants:** Emitted directly into the atmosphere (e.g., carbon monoxide, sulphur dioxide, nitrogen oxides, particulate matter).
2. **Secondary Pollutants:** Formed through chemical reactions in the atmosphere (e.g., ozone, smog, peroxyacetyl nitrates (PANs)).

### **PHOTOCHEMICAL OXIDATION**

Photochemical oxidation is essentially a complex process. It primarily occurs when sunlight reacts with pollutants such as nitric oxide (NO) and hydrocarbons (CH). This phenomenon was first identified in Los Angeles in 1943 and was subsequently observed in cities worldwide.

During photochemical smog formation, sunlight initiates chemical reactions that transform primary pollutants into secondary oxidants. The oxidation of nitrous oxides (NO<sub>2</sub>) and hydrocarbons (CH) leads to the formation of ozone (O<sub>3</sub>) as a major oxidant. Depending on the initial mixture of hydrocarbons and the intensity of atmospheric reactions, these minor oxidants contribute to smog effects.

Stable weather conditions, especially temperature inversions, favour the formation of photochemical smog. This increases the concentration of pollutants within urban air circulation. It maximizes pollution reaction interactions and prevents their dispersion. This

leads to the accumulation of oxidants over several days. The concentration and composition of oxidants vary across different locations and time periods.

## **Land Environment**

Approximately 29% of the Earth's surface is land. This creates a diverse topography consisting of mountains, plains, plateaus, valleys, and deserts. It serves as the foundation for ecosystems that support a wide variety of flora and fauna. Land plays a crucial role in agriculture, human habitation, and natural resource availability. It is essential for sustaining life on Earth. Soil, a major component of land, supports plant growth and regulates water systems. At the same time, forests and grasslands contribute to climate regulation by absorbing carbon dioxide.

Human activities have significantly altered natural ecosystems. This causes ecosystem destruction, biodiversity loss, and ecological imbalance. One of the main reasons for changes in the ecosystem is deforestation. Forests are cleared there for agriculture, urban development, and industrial activities. This not only causes soil erosion and climate change but also threatens the survival of numerous living species that depend on forest ecosystems. Similarly, urbanization and infrastructure development lead to the fragmentation of ecosystems and obstruct natural wildlife corridors and migratory patterns.

Another major cause of ecosystem loss is agricultural expansion. This is because forests and grasslands are converted into agricultural fields to meet the growing demand for food. The excessive use of chemical fertilizers and pesticides further deteriorates the quality of soil and water. Additionally, rising temperatures cause extreme events such as unpredictable weather patterns, droughts, and floods, which disrupt ecosystems. Melting polar ice caps, coral bleaching, and changes in forest ecosystems all affect biodiversity.

Pollution in various forms also causes the degradation of ecosystems. Soil, water, and air pollution from industrial waste, plastics, and chemicals adversely affect ecosystems and contaminate soil and water sources. Mining activities, such as clearing forests for coal mining or digging for fossil fuels, not only destroy the topography but also cause long-term soil degradation and pollution. Furthermore, the introduction of non-native plant and animal species significantly alters ecosystems, often overtaking native species and disrupting food chains.

The consequences of changes in the ecosystem are severe. Biodiversity loss is one of the most critical impacts, as living species lose their natural habitats and struggle to survive. Disruptions in ecosystems affect entire food chains. This leads to imbalances in predator-prey relationships. Soil degradation reduces agricultural productivity and causes desertification, while deforestation and urbanization increase natural disasters such as floods and landslides.

Deforestation also affects the climate, reducing the Earth's capacity to absorb carbon dioxide and accelerating global warming.

To mitigate these impacts, conservation and sustainable practices are essential. This will help with afforestation, restoring lost forests, and improving biodiversity. Sustainable agricultural practices such as organic farming and crop rotation help reduce environmental damage. Establishing protected areas like wildlife sanctuaries and national parks will help protect endangered species. In urban areas, eco-friendly infrastructure and green spaces promote sustainable living. Environmental policies also play a crucial role in controlling pollution and ensuring proper waste management for ecosystem conservation.

## **Biodiversity**

Biodiversity is the sum total of the differences between all living things on Earth (species diversity), differences within each other (genetic diversity), and the interactions between them. Biodiversity includes organisms such as plants, aquatic organisms, animals, microorganisms, and coral reefs, as well as the diversity of habitat such as forests, rainforests, deserts, wetlands, hills, mountains, and oceans.

That is, biodiversity manifests primarily at three levels: species diversity, genetic diversity, and ecosystem diversity.

**Species Diversity:** Species diversity refers to the number of living species throughout the biosphere, the differences evident in them, and their mutual interdependence. This includes both native and exotic species. Innumerable plants and animals are examples of species diversity. The latest assessments estimate that there are about 8.7 million species in this world, but the documented species diversity stands at only about 1.7 million species.

**Genetic Diversity:** Variations can be seen within each living species on Earth. The reason for this is the difference in their genes. It can be said that genetic diversity is the very foundation of biodiversity. Therefore, the variation found in the genes of each organism is genetic diversity. Humans utilize this genetic diversity in various ways to develop varieties with increased yield and disease resistance.

**Ecosystem Diversity (Ecosystem Diversity):** Every living organism constantly interacts and coexists in a mutually interdependent manner with other fellow organisms and abiotic components in its surroundings. Ecosystems are formed by the combination of such living communities and their environments. There are many different types of ecosystems such as forests, grasslands, deserts, mangroves, sacred groves (*kavukal*), wetlands, rivers, marshes, and oceans.

There are two types of methods for biodiversity conservation. First is conservation within the natural habitat (In situ conservation), and second is conservation outside the natural habitat (Ex situ conservation). Biosphere reserves, national parks, wildlife sanctuaries, community reserves, sacred groves, and biodiversity heritage sites are examples of *in situ* conservation.

Botanical gardens, biodiversity parks, zoos, aquariums, Miyawaki forests, and field gene banks are examples of *ex situ* conservation.

### **Agricultural Biodiversity**

Agro-biodiversity or agricultural biodiversity is an integral part of biodiversity itself. It is estimated that it has only been about 10,000 years since humans transitioned from living by gathering fruits and hunting animals to starting agriculture. Numerous plants were selected and cultivated after humans found them beneficial. Later, based on factors such as topography, soil, climate, and water availability within the same crop, many indigenous varieties (land races/ local varieties) emerged. It is a reality that applying modern breeding techniques based on these has helped eradicate starvation for the growing population. Unfortunately, as farmers began to cultivate only certain specific varieties focusing on economic profit, yield, and quality, genetic diversity was greatly reduced.

### **Degradation of Ecosystems**

Degradation of ecosystems refers to the decline in the quality of the natural environment caused by human activities and natural processes. This leads to the disruption of biodiversity and the functioning of ecosystems. This happens primarily due to deforestation, pollution, urbanization, and unsustainable agricultural practices.

#### **Causes of Ecosystem Degradation:**

- **Deforestation:** Clearing forests on a large scale for agriculture and other infrastructure development disrupts the ecosystem and reduces carbon sequestration.
- **Urban Development:** The construction of cities, roads, and industries leads to the fragmentation of ecosystems. This creates difficulties for the survival of living species.
- **Pollution:** Industrial waste, chemical waste, and plastic waste cause the pollution of air, water, and soil, which adversely affects the health of wildlife and plants.
- **Climate Change:** Rising temperatures, changes in rainfall patterns, and extreme weather events negatively impact the ecosystem.

#### **Consequences of Ecosystem Degradation:**

- Loss of biodiversity and extinction of species.
- Decline in ecosystem functions such as water purification and maintenance of air quality.
- Increased human-wildlife conflicts due to ecosystem degradation.
- Reduction in agricultural productivity due to soil degradation.

Conservation efforts, sustainable land-use planning, and afforestation programs are crucial to mitigating ecosystem destruction and restoring ecosystems.

### **Natural Disasters: Landslides, Soil Erosion, etc.**

Natural disasters like soil erosion has severe environmental, social, and economic consequences. Human activities such as deforestation and unplanned construction in fragile areas often aggravate these disasters.

#### ❖ Landslide

This occurs due to heavy rain, earthquakes, deforestation, and inappropriate land use. It causes loss of life, property damage, and displacement of communities. It also disrupts transportation and communication networks in hilly and mountainous regions.

#### ❖ Soil Erosion

Soil is gradually removed due to activities like agriculture, deforestation, and mining. This leads to the loss of fertile land, a decrease in agricultural productivity, and an increase in sedimentation in water bodies. Additionally, it increases the likelihood of floods and desertification.

#### Mitigation Measures:

- Implement afforestation and reforestation projects to stabilize the soil.
- Construct retaining walls, check dams, and terraces in areas prone to soil erosion.
- Adopt sustainable agricultural practices such as contour farming and cover cropping.
- Strengthen advance warning systems and preparedness programs for disaster mitigation.

#### **Unscientific Management of Waste**

Improper waste management is a critical environmental issue that affects public health, natural ecosystems, and overall sustainability. The indiscriminate disposal of solid, liquid, and hazardous waste leads to pollution and resource depletion.

- **Open Dumping:** Uncontrolled disposal leads to the pollution of soil and groundwater.
- **Burning of Waste:** Releases harmful gases like dioxins and furans. This causes air pollution and respiratory diseases.
- **Industrial and Biomedical Waste:** Improper management of toxic chemicals and medical waste creates severe health problems for both humans and wildlife.
- **Plastic Pollution:** Non-biodegradable plastics accumulate in water bodies and soil, affecting marine and terrestrial ecosystems.

#### **Consequences of Improper Waste Management:**

- Pollution of water sources leads to waterborne diseases.
- Air pollution caused by the burning of waste.
- Soil degradation severely affects agriculture and plant growth.

- Accumulation of stagnant waste increases the risk of vector-borne diseases transmitted by pathogens, such as dengue and malaria.

#### **Solutions and Preventive Measures:**

- Implement proper segregation of waste at the source itself into organic waste, recyclables, and hazardous waste.
- Promote reuse, composting, and sustainable waste disposal methods.
- Strengthen regulations regarding industrial waste management and enforce strict penalties for violations.
- Create public awareness regarding responsible waste disposal and environmental conservation.

## **Climate Change and Related Environmental Impacts**

### **Greenhouse Gases and Environmental Balance**

The Earth's atmosphere protects us like a blanket, forming a shield composed of various gases. Through the action of certain gases in the atmosphere, an "atmospheric window" is formed. This window allows only the components of the solar spectrum that are essential for sustaining life on Earth to pass through. Greenhouse gases such as carbon dioxide (CO<sub>2</sub>), methane, and nitrous oxide play a major role in this process.

Generally, the atmosphere allows shortwave radiations from the solar spectrum to pass through to the Earth. These radiations are absorbed by the Earth's surface. Later, when the Earth reflects these rays back, they transform into longwave radiations, which are then absorbed and trapped by the greenhouse gases and water droplets in the atmosphere. As a result, a temperature suitable for life is maintained on Earth. This phenomenon is called the greenhouse effect. This process is a crucial factor in maintaining the Earth's essential average temperature of 15.5 °C required for the survival of life. However, if the concentration of these gases in the atmosphere exceeds a certain limit, it leads to global warming, which endangers the existence of life on Earth and disrupts the environmental balance.

## **What is Climate Change? How Does It Occur?**

Climate change refers to the long-term changes that occur in daily atmospheric conditions.

The very evolution of the Earth is due to climate change. Just as the Industrial Revolution played a distinct role in the advancement of humanity, it has also caused an unprecedented increase in the levels of greenhouse gases in the atmosphere. While the concentration of CO<sub>2</sub> in the atmosphere during the Industrial Revolution era was 330 ppm, today it has increased to 418 ppm, causing a rise of approximately 1.5 °C in the global warming rate. Studies show that all these factors have created distinct variations in our state, resulting in higher temperatures during the summer and lower temperatures during the winter over the past hundred years (SAPCC 2.0).

## **Consequences of Climate Change**

- Melting of glaciers in polar regions
- Rising sea levels
- Coastal flooding
- Intrusion of saltwater into drinking water sources

## **How to Survive the Era of Climate Change**

### **1. Climate Change Adaptation**

To make climate change adaptation possible, it is essential for each sector or individual to analyse their vulnerability and adaptive capacity and implement appropriate interventions at the right time. For example, the immediate threat faced by an individual living on a riverbank is flooding, which can occur at any time. However, adaptive capacity relates to the preparedness measures that the individual takes to face that situation, such as learning how to swim.

### **2. Climate Change Mitigation / Reducing Carbon Emissions**

- **Energy Sector:** Utilization of renewable energy, including solar rooftops, solar power, electric vehicles, wind energy, and energy storage systems.
- **Hydropower:** Pumped storage systems.
- **Waste Management:** Management of solid and liquid waste.

## **Carbon Sequestration**

This process involves capturing and storing atmospheric carbon dioxide, thereby making it possible to reduce the overall level of carbon dioxide in the atmosphere.

## **Food Safety Department**

### **Foodborne Diseases and Control Measures**

Food safety authorities worldwide are responsible for monitoring and controlling foodborne diseases that are important to public health. As the volume and scope of the global food trade increase, food safety authorities must be able to identify and respond to food safety issues and communicate information to all relevant sectors within the shortest possible time.

Efficient monitoring and control of foodborne diseases require the collaborative effort of various fields, including clinical medicine, epidemiology, laboratory medicine, food microbiology, chemistry, food safety, food control, and risk communication and management.

### **Definitions**

**Food Safety Incidents:** The potential for hazards or illnesses to occur within the food supply chain, or a confirmed illness associated with the consumption of food.

Foodborne Disease: Any disease or food poisoning caused by the consumption of food contaminated with pathogens such as bacteria, viruses, or parasites.

A food poisoning outbreak can be said to occur when the number of people affected by a particular disease that could be foodborne increases unusually, or when a situation arises where two or more people develop foodborne illnesses as a result of consuming food.

## **Overview of Foodborne Diseases**

Symptoms indicating that a person has a foodborne disease transmitted through food may include vomiting, diarrhea, nausea, fever, and abdominal pain. Hepatitis A or jaundice caused by it may also be included.

Infections transmitted through food spread and multiply into the intestines or other tissues. *Salmonella*, *Campylobacter*, *Vibrio*, and *Yersinia enterocolitica* are examples.

The list of major pathogens causing foodborne diseases, their characteristics, and the control measures to be taken at the industrial level, institutional level, and consumer level are provided below.

|                                      |                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sl No                                | 1                                                                                                                                                                                                                                                                                                                                        |
| Name of Pathogen                     | Staphylococcus aureus                                                                                                                                                                                                                                                                                                                    |
| Common Name of Disease               | Staphylococcus aureus intoxication                                                                                                                                                                                                                                                                                                       |
| Onset of Symptoms                    | 1 to 7 hours                                                                                                                                                                                                                                                                                                                             |
| Common Signs and Symptoms            | Nausea, abdominal pain, vomiting, diarrhea. In highly severe cases – dehydration, headache, muscle cramps, sudden changes in blood pressure and pulse rate.                                                                                                                                                                              |
| Major Food Items Causing the Disease | Meat, meat products; poultry, egg products; salads such as potato and macaroni; bakery products like cream-filled pastries and chocolate candy; sandwich fillings; milk and milk products.                                                                                                                                               |
| Target Group                         | It is believed that all people are susceptible to this type of bacterial infection. However, the severity of symptoms can vary.                                                                                                                                                                                                          |
| Specific Control Measures            | <p>Food establishments / institutions / home:</p> <p>Exclude individuals with visible skin infections (burns, wounds, etc.) from food handling work;</p> <p>-Personal hygiene;</p> <p>-Consume cooked/prepared food within a specified period</p> <p>-Heat treatment, and proper hygiene practices during production and processing.</p> |

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|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sl No                                | 2                                                                                                                                                                                                                                                                                                                 |
| Name of Pathogen                     | Bacillus cereus                                                                                                                                                                                                                                                                                                   |
| Common Name of Disease               | <p>Bacillus cereus food poisoning is of two types:</p> <p>1) Diarrheal type</p> <p>2) Emetic type</p>                                                                                                                                                                                                             |
| Onset of Symptoms                    | <p>1. Diarrheal: 6 to 15 hours</p> <p>2. Emetic: 0.5 to 6 hours</p>                                                                                                                                                                                                                                               |
| Common Signs and Symptoms            | <p>1. Diarrheal : Severe diarrhea, nausea, abdominal pain.</p> <p>2. Emetic : Severe nausea, vomiting, abdominal cramps. Diarrhea may occur in some cases.</p>                                                                                                                                                    |
| Major Food Items Causing the Disease | <p>Starch-containing products such as rice, fried rice, potato, pasta, and cheese products; spices, dried foods, milk, dairy products, raw vegetable dishes, sauces, puddings, soups, pastries, salads.</p> <p>The emetic type usually infects through rice or fried rice that has been kept open and stored.</p> |
| Target Group                         | Anyone can be affected by Bacillus cereus food poisoning.                                                                                                                                                                                                                                                         |
| Specific Control Measures            | <p>Maintain effective temperatures to prevent the growth of dangerous microbes (Spore germination).</p> <p>Follow proper hygiene practices during production and processing.</p>                                                                                                                                  |

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|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SI No                                | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Name of Pathogen                     | Salmonella                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Common Name of Disease               | Salmonellosis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Onset of Symptoms                    | 6 to 72 hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Common Signs and Symptoms            | Nausea, vomiting, abdominal pain, diarrhea, fever, headache.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Major Food Items Causing the Disease | Meat, chicken, egg, milk, dairy products, fish, shrimp, spices, yeast, coconut, sauces, salad dressings made with unpasteurised egg (mayonnaise), cake mixes, cream-filled desserts, toppings containing egg, dried gelatin, peanut butter, cocoa, products (fruits and vegetables, tomatoes, pepper), chocolate.                                                                                                                                                                                                                                                                                                                                          |
| Target Group                         | Salmonella can affect individuals of any age group.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Specific Control Measures            | <p>Industrial: Pasteurization of milk and eggs; ensure meat is thoroughly cooked before consumption. Follow good hygiene practices during production and processing; vaccinate egg-laying flocks.</p> <p>Food Supply Establishment / Home: Safe practices , including safe preparation, cooking, and reheating of milk;</p> <p>Adequate refrigeration; prevent cross-contamination of food items; keep food preparation areas clean and sanitized; keep pets and other animals away from food handling areas</p> <p>Consumers: Individuals with compromised immunity, in particular, should completely avoid undercooked meat, chicken, milk and eggs.</p> |

|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sl No                                | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Name of Pathogen                     | Campylobacter jejuni                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Common Name of Disease               | Campylobacteriosis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Onset of Symptoms                    | 2 to 5 days                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Common Signs and Symptoms            | Fever, diarrhea, abdominal pain, vomiting.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Major Food Items Causing the Disease | Chicken products that are not properly processed or cooked; unpasteurized milk; fish and shellfish from contaminated water; contaminated water; vegetables and seafood; chlorinated water from streams and ponds.                                                                                                                                                                                                                                                                                                                                                                            |
| Target Group                         | Children under 5 years of age, and individuals between 15 to 29 years of age.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Specific Control Measures            | <p>Industrial: (Pasteurization/sterilization of milk); ensure cleanliness of slaughterhouses. Conduct heat radiation of meat and chicken.; wash in clean water; follow good hygiene practices during production and processing.</p> <p>Food Supply Establishment / Home: Boil milk; cook meat thoroughly; wash salads and vegetables; prevent cross-contamination; maintain personal hygiene while preparing food (wash hands after contact with animals); keep pets away from food handling areas.</p> <p>Avoid consuming raw/undercooked chicken or milk that has not properly boiled.</p> |

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| Sl No                               | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Name of Pathogen                    | <i>Listeria monocytogenes</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Common Name of the Disease          | Listeriosis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Onset of Symptoms                   | From a few hours up to 2 or 3 days                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Common Signs and Symptoms           | Influenza-like fever, headache, occasional symptoms of digestive problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Main Food Items Causing the Disease | Raw milk, unpasteurized milk, chocolate milk, cheeses—especially soft cheeses, ice cream, raw vegetables, raw chicken, meat, sausages, sandwiches, raw and smoked fish, other seafood.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Target Group                        | Pregnant women, immunocompromised individuals, cancer patients, those with serious illnesses / health problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Specific Control Measures           | <p>Industrial: Boiling of milk (sterilization, pasteurization), ready-to-eat, high-risk processed food, reduce the risk of cross-contamination (mutual contamination) post-processing.<br/>Follow good hygiene practices during production and processing.</p> <p>Food Supply Establishment / Home: Use milk and dairy products that are pasteurized or thoroughly boiled; refrigerate perishable foods and consume within a short period. Food that has been cooked and stored in the fridge must be thoroughly reheated before consumption. Avoid certain high-risk foods, e.g., soft cheese, patties; avoid raw milk and unpasteurized dairy products during pregnancy.</p> <p>Consumers: Especially pregnant women and immunocompromised individuals should avoid eating unprocessed food from animal sources.<br/>Eg: Pregnant women should also avoid foods that can support the growth of <i>Listeria</i>, such as meat and raw milk, soft cheese, pre-prepared salads, cold- smoked foods and raw seafood.</p> |

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| Sl No                               | 6                                                                                                                                                                                                                                                                                                                                                                                       |
| Name of Pathogen                    | Enterotoxigenic E. coli (ETEC)                                                                                                                                                                                                                                                                                                                                                          |
| Common Name of the Disease          | Escherichia coli Infection                                                                                                                                                                                                                                                                                                                                                              |
| Onset of Symptoms                   | 10–12 hours to 1–3 days                                                                                                                                                                                                                                                                                                                                                                 |
| Common Signs and Symptoms           | Ranging from mild diarrhea to severe, cholera-like illness; additionally, abdominal pain and vomiting, which can sometimes lead to severe dehydration.                                                                                                                                                                                                                                  |
| Main Food Items Causing the Disease | Meat, raw (unpasteurized) milk, vegetables                                                                                                                                                                                                                                                                                                                                              |
| Target Group                        | -----                                                                                                                                                                                                                                                                                                                                                                                   |
| Specific Control Measures           | <p>Industrial: Purification of drinking water, effective wastewater disposal system, water purification; heat treatment; maintaining hygiene during production and processing.</p> <p>Food Supply Establishment/Home: Take measures to prevent direct or indirect contamination of food and water by faecal matter; cook food well, reheat [thoroughly]; maintain personal hygiene.</p> |

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| Sl No                               | 7                                                                                                                                                                                                                                                                                                                                          |
| Name of Pathogen                    | Enterohemorrhagic E.coli                                                                                                                                                                                                                                                                                                                   |
| Common Name of the Disease          | Escherichia coli Infection                                                                                                                                                                                                                                                                                                                 |
| Onset of Symptoms                   | 3–8 days                                                                                                                                                                                                                                                                                                                                   |
| Common Signs and Symptoms           | Constipation, diarrhea may change into bloody diarrhea (hemorrhagic colitis); fever and vomiting may also occur.                                                                                                                                                                                                                           |
| Main Food Items Causing the Disease | -----                                                                                                                                                                                                                                                                                                                                      |
| Target Group                        | -----                                                                                                                                                                                                                                                                                                                                      |
| Specific Control Measures           | <p>EHEC Infection, Control Measures</p> <p>Industrial: Conduct heat treatment of meat or process by irradiation; pasteurization/sterilization of milk; purification of wastewater used for irrigation.</p> <p>Food Supply Establishment/Home Cook meat thoroughly; boil milk / use pasteurized milk; wash hands before preparing food.</p> |

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| Sl No                               | 8                                |
| Name of Pathogen                    | Enteropathogenic E.coli(EPEC)    |
| Common Name of the Disease          | Escherichia coli Infection       |
| Onset of Symptoms                   | 16 days: up to 12-36 hours       |
| Common Signs and Symptoms           | Diarrhea, abdominal pain , Fever |
| Main Food Items Causing the Disease | -----                            |
| Target Group                        | -----                            |
| Specific Control Measures           | -----                            |

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| Sl No                               | 9                                                                                                                                                                                                                                                                                                                        |
| Name of Pathogen                    | Enteroinvasive E. coli (EIEC)                                                                                                                                                                                                                                                                                            |
| Common Name of the Disease          | Escherichia coli Infection                                                                                                                                                                                                                                                                                               |
| Onset of Symptoms                   | 13 days; up to 10–18 hours                                                                                                                                                                                                                                                                                               |
| Common Signs and Symptoms           | EIEC multiplies in the epithelial cells of the large intestine, causing inflammation of the mucosa and sub-mucosa. Symptoms include fever, abdominal pain, vomiting, and diarrhea (blood and mucus may be seen in the stool in 10% of cases).                                                                            |
| Main Food Items Causing the Disease | -----                                                                                                                                                                                                                                                                                                                    |
| Target Group                        | -----                                                                                                                                                                                                                                                                                                                    |
| Specific Control Measures           | <p>Consumers should avoid eating raw/partially cooked meat and chicken and drinking raw milk.</p> <p>Infected individuals:<br/> Absence from work/school: For non-risk group cases, until 48 hours after the diarrhea has subsided.</p> <p>For contacts in risk groups, until microbiological clearance is obtained.</p> |

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| Sl No                      | 10                                                                                                                                           |
| Name of Pathogen           | Clostridium Botulinum                                                                                                                        |
| Common Name of the Disease | Botulism                                                                                                                                     |
| Onset of Symptoms          | 12-72 hours                                                                                                                                  |
| Common Signs and Symptoms  | Vomiting, diarrhea, blurred vision, double vision, difficulty swallowing, muscle weakness. It can also cause respiratory distress and death. |

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| Main Food Items Causing the Disease | Improperly canned foods, especially home-canned vegetables, fermented fish, baked potatoes wrapped in aluminium foil, and giving honey to infants cause botulism. Numerous botulism outbreaks have occurred because of consuming improperly cleaned fish, garlic stored in oil, and baked potatoes.                                                                                                                                                                                                                                                                                        |
| Target Group                        | Botulism disease can affect people of all age groups.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Specific Control Measures           | <p>Industrial: Sterilization, use of nitrates in pasteurized meat; heat treatment; maintain good hygiene practices during production and processing.</p> <p>Food Service Establishment/Home:</p> <ul style="list-style-type: none"> <li>• Preserve food at a low pH (&lt; 4.6).</li> <li>• Use canned food.</li> <li>• Cook well (boil and stir for 15 minutes).</li> <li>• Keep food refrigerated, especially food that is vacuum-packed or smoked.</li> <li>• Consumers should avoid giving honey or food items containing honey to infants.</li> <li>• Discard swollen cans.</li> </ul> |

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| Sl No                               | 11                                                                                                                                                                                                                                                                       |
| Name of Pathogen                    | <u>Clostridium perfringens</u>                                                                                                                                                                                                                                           |
| Common Name of the Disease          | Perfringens food poisoning                                                                                                                                                                                                                                               |
| Onset of Symptoms                   | 8 to 24 hours                                                                                                                                                                                                                                                            |
| Common Signs and Symptoms           | Intense abdominal pain, diarrhea                                                                                                                                                                                                                                         |
| Main Food Items Causing the Disease | Meat, poultry, gravy, precooked food                                                                                                                                                                                                                                     |
| Target Group                        | Clostridium perfringens poisoning is common in places where large quantities of food are prepared hours before serving (school cafeterias, hospitals, nursing homes, prisons, etc.). The young and the elderly are most susceptible to Clostridium perfringens poisoning |
| Specific Control Measures           | Food service establishment/Home: Keep cooked products properly chilled. Meat-                                                                                                                                                                                            |

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|  | based sauces and large pieces of meat should be chilled and stored below 10°C; reheat stored food thoroughly before eating; prepare food only in required quantities; thermal processing; maintain good hygiene practices during production and processing. |
|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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| Sl No                               | 12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Name of Pathogen                    | Shigella                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Common Name of the Disease          | Shigellosis or Bacillary dysentery                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Onset of Symptoms                   | 1–3 days, up to 1 week                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Common Signs and Symptoms           | Abdominal pain, fever, diarrhea which may contain mucus and blood                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Main Food Items Causing the Disease | Mixed salads, vegetables, water, unpasteurized milk                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Target Group                        | All people are susceptible to Shigellosis to some extent, but children under 14 years of age, the elderly, and immunocompromised individuals face the highest risk of danger.                                                                                                                                                                                                                                                                                                                                   |
| Specific Control Measures           | <p>Industrial: Purification of drinking water, effective waste disposal system, thermal processing; maintain good hygiene practices during production and processing.</p> <p>Food service establishment / Home: Wash hands using soap and water; ensure food is thoroughly cooked and reheated properly before consumption ;disinfect food preparation surfaces, wash all fruits and vegetables thoroughly. People infected with Shigella should not handle food, care for children, or attend to patients.</p> |

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| Sl No                               | 13                                                                                                                                                                                                                            |
| Name of Pathogen                    | Vibrio                                                                                                                                                                                                                        |
| Common Name of the Disease          | Cholera                                                                                                                                                                                                                       |
| Onset of Symptoms                   | Few hours to 3 days                                                                                                                                                                                                           |
| Common Signs and Symptoms           | <p>1) If the water and salt lost from the body due to severe diarrhea are not replenished properly, it can lead to dangerous dehydration, exhaustion, and death within a few hours.</p> <p>2) Abdominal pain and vomiting</p> |
| Main Food Items Causing the Disease | Raw or improperly cooked seafood items such as raw shellfish (oysters, mussels,                                                                                                                                               |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           | clams, crabs, lobsters, shrimp, squid, finfish, etc.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Specific Control Measures | <p>Industrial: Safe disposal of sewage and waste water; purification of drinking water (e.g., chlorination, radiation); heat preservation of foods (e.g., canning); storing at high pressure; maintaining good hygiene practices during production and processing.</p> <p>Food service establishment/Home: Personal hygiene (washing hands with soap and water); cook food thoroughly; wash fruits and vegetables carefully; use boiled drinking water when safe water is unavailable.</p> <p>Consumers: Avoid consuming raw seafood products.</p> |

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| Sl No                               | 14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Name of Pathogen                    | Hepatitis A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Common Name of the Disease          | Hepatitis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Onset of Symptoms                   | 25- 28 days(26 weeks)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Common Signs and Symptoms           | Loss of appetite, diarrhea, abdominal pain, exhaustion, vomiting, symptoms of ongoing liver damage (dark urine, pale stool, jaundice)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Main Food Items Causing the Disease | Raw fruits and vegetables, bakery products, contaminated drinking water; shellfish/clams from contaminated water                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Target Group                        | People of all age groups are susceptible to HAV infection.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Specific Control Measures           | <p>Industrial: Water purification; safe disposal of sewage.</p> <p>Food service establishment / Home: Good personal hygiene, especially washing hands thoroughly with soap and water before handling food; infected individuals must refrain from handling food; thorough cooking of shellfish; heat treatment; maintain good hygiene practices during production and processing. Effective vaccine is available; vaccination of food handlers and travellers should be considered. To prevent the disease, immune serum globulin is effective within 14 days of exposure to Hepatitis A. Exclude from work/school for 7</p> |

|  |                                                    |
|--|----------------------------------------------------|
|  | days after the onset of jaundice/illness symptoms. |
|--|----------------------------------------------------|

## Common Contaminants / Toxic Substances / Residues / Antibiotics and Control Measures

### Contaminants

| Name of Contaminant                                                                       | Food Items / Goods                                                      | Control Measures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Heavy Metals<br>(Lead, Arsenic, Copper, Tin, Zinc, Mercury, Chromium, Nickel, Cadmium) | Bottled water, turmeric, canned fish, meat, other processed food drinks | <ol style="list-style-type: none"> <li>1. Control groundwater pollution</li> <li>2. Process/dispose of e-waste safely</li> <li>3. Follow good manufacturing and processing practices</li> <li>4. Periodically test prepared food items and water</li> </ol>                                                                                                                                                                                                                                                    |
| 2. Crop Contamination and Natural Toxic Substances<br>(Aflatoxin, Ochratoxin)             | All food items (mainly wheat, barley, rye, peanut), milk (Aflatoxin M1) | Follow good agricultural practices (proper post-harvest storage, avoid feeding mould-infected feed to animals)                                                                                                                                                                                                                                                                                                                                                                                                 |
| 3. Residues of Pesticides and Weedicides                                                  | All agricultural products and water                                     | <ul style="list-style-type: none"> <li>• Good agricultural practices – Washing in clean running water reduces pesticide residue by 75–80%.</li> <li>• Washing using a 2% concentration salt solution will remove most of the contact pesticide residue.</li> <li>• Lemon / baking soda wash (1 teaspoon lemon juice, 2 teaspoons baking soda + 250 ml water) spray on fruits and vegetables.</li> <li>• Keep this for 5–10 minutes</li> <li>• ¼ cup vinegar, 2 tablespoons salt in 1 liter of water</li> </ul> |

|               |                         |                                                                                                                                                                               |
|---------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                         | <ul style="list-style-type: none"> <li>• Soak vegetables for 20 minutes</li> <li>• Wash before use</li> <li>• Peeling skin</li> <li>• Clean with hot water / steam</li> </ul> |
| 4. Antibiotic | Milk, meat, fish, honey | Scientific use of antibiotics in the agricultural sector.                                                                                                                     |

## **Food Safety Law, Laws and Regulations**

### **Origin of the Food Safety and Standards Act, 2006**

Prior to the coming into force of the Food Safety and Standards Act, 2006, various ministries of the Government of India had enacted several food-related legislations. Before the food safety and quality law came into effect, at least eight laws or control guidelines related to food products existed. Over time, this led to mutually contradictory standards and differing enforcement agencies. This created confusion among food businesses, consumers, traders, food manufacturers, and investors. Recognizing that the existing laws and orders were inadequate, the Prime Minister's Council on Trade and Industry in 1998 recommended enacting a unified, comprehensive food law by integrating existing systems to simplify food laws and ensure safety. In 2004, the Joint Parliamentary Committee (JPC) emphasized that all existing food laws should be unified and that there should be a single regulatory body across India. The Food Safety and Standards Bill, 2005 was passed by both houses of Parliament and became law on August 2, 2006.

### **Food Safety and Quality Regulations**

Section 92(1) of the Food Safety and Standards Act, 2006 empowers the Food Authority to make regulations and standards consistent with this Act and the rules made thereunder. Following the enforcement of the Food Safety and Standards Act, 2006, the FSSAI drafted rules and regulations through consultations and discussions with various sectors. These regulations were notified in the Gazette of India on August 1, 2011 and came into effect on August 5, 2011. To prevent the excessive use of pesticides and the indiscriminate use of antibiotics and other drugs, FSSAI notified the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011.

### **General Principles of Food Safety**

Food is defined as any substance that provides nourishment to our body. It generally consists of carbohydrates, fats, proteins, vitamins, or essential nutrients like minerals, which provide energy for body growth and all functions. It keeps the immune system healthy. The primary sources of energy derived from food are fats, proteins, and carbohydrates.

According to the Food Safety and Standards Act, 2006, 'Food' means: "Any substance, whether processed, partially processed or unprocessed which is intended for human consumption and includes primary food, genetically modified or engineered food or food containing such ingredients, infant food, packaged drinking water, alcoholic drink, chewing gum and any substance including water used into the food during its manufacture, preparation or treatment but does not include any animal feed, live animals unless they are prepared or processed for placing on the market for human consumption, plants, prior to harvesting, drugs and medicinal products, cosmetics, narcotic or psychotropic substance". According to the 2006 Food Safety and Standards Act, "Food Safety" means "assurance that food is acceptable for human consumption according to its intended use". Consuming clean, safe, and nutritious food is

crucial for sustaining life and maintaining good health. Contaminated food containing pathogenic bacteria, viruses, parasites, or toxic chemicals is the cause of over 200 different diseases—ranging from diarrhea to cancer.

Every year, 1 in 10 people fall ill by consuming contaminated food. Although food safety is a shared responsibility, food industries, consumers, and food handlers have a major role to play in preventing foodborne illnesses.

### **‘Five Keys to Safer Food’ Developed by the World Health Organization**

#### **1. Keep Clean**

- Wash hands with soap before handling food and during food preparation.
- Wash hands with soap after using the toilet.
- Wash and sanitize all surfaces and equipment used for food preparation.
- Protect kitchen areas and food from insects, pests, and other animals.

#### **2. Separate raw and cooked food**

- Separate raw meat, poultry, and seafood from other foods.
- Use separate equipment and utensils, such as knives and cutting boards, for handling raw food.

Store food in separate containers to avoid contact between raw and cooked foods.

#### **3. Cook thoroughly**

- Cook food thoroughly, especially meat, poultry, eggs, and seafood.
- Bring foods like soups and stews to a boil to ensure they have reached 70 °C. Make sure that juices from meat and poultry are clear, not pink.
- Reheat cooked food thoroughly.

#### **4. Keep food at safe temperatures**

- Do not leave cooked food at room temperature for more than two hours.
- Refrigerate promptly all cooked and perishable food (preferably below 5 °C).

#### **5. Use safe water and raw materials**

- Use safe water or treat it to make it safe.
- Select fresh and wholesome foods.
- Choose foods processed for safety, such as pasteurized milk.
- Wash fruits and vegetables thoroughly, especially if they are eaten raw.
- Do not use food beyond its expiry date.

## **Session 3**

### **One Health – Kerala And Organisation Structure**

Like many other health initiatives, Kerala is at the forefront of implementing the One Health program in the country. Kerala's unique characteristics include an extensive forest area resulting in high human-wildlife contact, high population density, large-scale international travel due to a high non-resident population, and a relatively high prevalence of non-communicable diseases among its aging population. Therefore, the rate of co-morbidity is dangerously high compared to other Indian states. The frequent and recurring outbreaks of zoonotic diseases such as Nipah virus, H1N1, and Kyasanur Forest Disease (Monkey Fever), as well as vector-borne diseases like Chikungunya and Dengue fever, pose a major threat to the health sector. Leptospirosis, an infectious disease transmitted through rats and livestock, is another major threat. The COVID-19 pandemic situation highlights the challenges/crises the state may face in tackling future epidemics. It is against this backdrop that the Government of Kerala has initiated steps to implement the One Health program in the state.

As part of the Nava Keralam Karma Padhathi-2, the Hon'ble Chief Minister inaugurated the One Health program in Kerala on May 17, 2022. In the first phase, the program is being implemented in four Pamba river basin districts: Pathanamthitta, Alappuzha, Kottayam, and Idukki. The program is being implemented under the Rebuild Kerala Initiative (RKI) with financial assistance from the International Bank for Reconstruction and Development (IBRD) and the Asian Infrastructure Investment Bank (AIIB).

The World Bank has approved a multi-level resilience program aimed at increasing the efficiency of resilience activities within the state against the impacts of natural disasters, including climate change and infectious diseases.

Although this program is mainly focused on the Pamba river basin districts, several innovative projects have been proposed across the state as part of this program. This includes an IT-based One Health monitoring system from the grassroots level of society, strengthening of Public Health Laboratories at the district level, and strengthening the data triangulation system of the Prevention of Epidemic and Infectious Diseases (PEID) cells in all medical colleges. The program is implemented based on the concept of 'Program for Results' (P for R) or result-oriented project. According to this concept, funds will be distributed based on achieving specified targets or goals in accordance with Disbursement Linked Indicators (D.L.I.).

### **Activities of the State-Level One Health Committee**

The leadership and supervision of the One Health programme in the state are managed by the State One Health Committee. This committee ensures that the One Health programme is

implemented in a time-bound manner by issuing government orders and policy guidelines necessary to ensure effective coordination and cooperation between the participating departments. The committee ensures that the programme is implemented within the stipulated timeframe by providing necessary guidelines for the state-level launch of the One Health programme and for programme planning in the four Pamba basin districts. Subsequently, overseeing the expansion of the programme to the remaining ten districts is also part of the committee's responsibilities. It is also the responsibility of the State-Level Committee to review activities aimed at capacity building for projects included under the One Health programme and to provide directions for follow-up actions.

### **Activities of the District-Level Committee**

The leadership and supervision of One Health programme activities within the district are carried out by the District-Level Committee. The District-Level Committee is responsible for forming a District Executive Committee to plan and analyse projects, conduct necessary field visits, and strengthen and monitor the programme. This committee is also responsible for forming a resource group to provide all necessary guidelines and assistance to other officials, as well as managing documentation work. Joint visits by various departments, necessary for overseeing programme implementation—such as visits to places like fish and meat markets with a high potential for zoonotic disease transmission, and investigations into circumstances surrounding disease outbreaks—are conducted under the leadership of the District-Level Committee. Additionally, ensuring training for employees of all line departments, communication between departments, and the exchange of required information are responsibilities of the District Committee.

### **Activities of the Local Self-Government Level (Regional) Committee**

- Provide leadership for implementing the One Health programme at the regional level.
- Deploy regional representatives in accordance with the concept of the One Health programme.
- Hold consultations for activities, including the selection of a Nodal Officer (Medical Officer) for implementing the One Health programme in the respective region, and finalize the LSG (Local Self-Government) level coordination mechanism.
- Plan and implement programmes in cooperation with the LSG, with the objective of building community capacity to enable them to undertake One Health surveillance activities.

### **Role of Local Self-Governments in the One Health Approach**

The activities of Local Self-Governments (LSGs) to achieve Sustainable Development Goals must be based on the slogan "Health for All, Health in All." Health-centred development is the way forward. LSGs must be prepared to take the initiative in identifying and proactively

resolving issues that may arise during the implementation and utilization of health conservation activities. Furthermore, LSGs must accord due importance to preventive and promotive health care, as well as palliative care. Disease prevention, health promotion activities, and medical treatment should all be primary considerations for Local Self-Governments.

LSGs should act as a driving force to foster a healthy culture in a way that enables the community to become the guardians of their own health. Improving the health standards of the community can reduce out-of-pocket expenditure on healthcare. The performance of Local Self-Governments needs to be evaluated based on the health indicators of their respective regions.

### **Identifying Health Issues**

LSGs must formulate development goals aligned with the State Sustainable Development Goals (SDGs). To identify health issues and set targets for each region, the Health Working Group of the LSG should prepare an annual Health Status Report (HSR). The Health Status Report must be prepared based on statistical data collected from various sources. This process will only be effective if the LSG monitors and ensures that registers are temporary and that the data collection system is efficient in providing accurate data. Health Status Reports should evaluate whether the service delivery systems in the respective regions are functioning in a targeted manner. Existing problems, their extent, their impact on the community, and the remaining issues that cannot be resolved through currently provided services must be tabulated, and mechanisms should be established to consider them on a priority basis. To find the most appropriate solutions, these problems must be discussed with relevant stakeholders based on priority.

### **Resource Mobilization**

The information available within the LSG (Local Self-Government) may be insufficient to address all identified health problems. Therefore, LSGs should be able to identify additional helpful sources of information and components for problem-solving and utilize them appropriately. Necessary information should be gathered from research conducted by working groups. In addition to financial, material, and human resource assistance from Corporate Social Responsibility (CSR) programs, NGOs, private institutions, clubs, and charitable organizations, funds available from Central Government programs, Block Panchayats, and District Panchayats can also be utilized for these activities.

### **Health Services**

It is a major responsibility of the LSG to ensure an adequate allocation of resources for various components of healthcare, such as improved disease prevention, promotion of health protection, medical treatment, palliative care, and rehabilitation. LSGs must ensure the infrastructure development and proper maintenance of health institutions to improve the delivery of health protection services. LSGs must ensure the availability of medicines,

chemicals, and equipment as per requirement. Staff should be provided wherever additional human resources are required. Transportation facilities for field, outreach, and referral services must be ensured. Clean drinking water must be made available, and the sanitation of the institution must be ensured. The intervention of LSGs is essential in developing sub-centres / Janakeeya Arogya Kendrams as a nodal point for disease prevention and the promotion required for health protection.

### **Empowerment of Individuals through Local Collectives**

To foster a culture of health in society, there needs to be a change in approach toward matters like waste management, dietary habits, water literacy, environmental conservation, and exercise. It is a relevant component to empower individuals with the help of local groups such as Ayalsabha(neighbouring groups), Ward Sabhas, Ayalkoottam, Grama Sabhas, Mother's Associations, PTA, Kudumbashree, Urukootam (tribal hamlets), Ward-level Health and Sanitation Nutrition Committees, Padasekhara (paddy field) Development Committees, social-political organizations, agricultural organizations, self-help groups, and arts and sports clubs.

### **Identifying Social Determinants Influencing Health**

Excellent efforts must be made under the leadership of the LSG (Local Self-Government) to address health-related social determinants through LSG projects that integrate departments such as General Education, Water, Agriculture, Animal Husbandry, ICDS (Integrated Child Development Services), and Local Self-Governance. These initiatives should target poverty alleviation, availability of nutritious food, hunger, primary education, gender equality and women's empowerment, waste management, clean water and sanitation, clean energy, social justice, and environmental conservation.

The LSG must provide leadership in implementing various services, such as opening school playgrounds to the general public for physical training, forming exercise groups, creating organic farming groups, setting up play areas for children, and establishing gym facilities for senior citizens/adults. It is also the responsibility of LSGs to ensure the necessary support for implementing public health laws.



In Kerala, the implementation responsibility of the One Health Programme rests with the Centre for One Health-Kerala (COHK) under the Directorate of Health Services. Under COH-K, there is a State Program Management Unit (SPMU), a District Program Support Unit (DPSU), and LSG-level One Health Committees. To develop One Health policies, guidelines, and SOPs (Standard Operating Procedures) including those at district levels, and for continuous monitoring, the COH-K-SPMU will be established within the Directorate of Health Services.

The DPSU will provide procedural support to district authorities and local governments. Training programmes for human resource empowerment, assistance required to implement programmes, and capacity-building support will be planned and implemented in collaboration with various stakeholders of the programme. Currently, DPSUs are being established in the four Pamba river basin districts where the programme is being implemented: Pathanamthitta, Kottayam, Alappuzha, and Idukki. The One Health District Nodal Officer, who is also the Aardram Nodal Officer, will coordinate the activities of these units.

The DPSU will operate either at the District Medical Offices or at other convenient locations designated by the District Medical Officer.

### **Governance Structure of One Health Programme**

#### **At the State Level**

- **Chairperson:** Hon. Minister for Health, Woman and Child Development
- **Vice Chairperson:** Principal Secretary, Department of Health and Family Welfare
- **Convener:** Director of Health Services

#### **Members:**

- Additional Secretary, Department of Health and Family Welfare
- State Mission Director, National Health Mission
- Project Director, e-Health
- Managing Director, Kerala Medical Services Corporation Limited
- Joint Secretary, Department of Health and Family Welfare
- Director, Panchayat
- Director, Urban Affairs
- Director, Animal Husbandry
- Director, Fisheries
- Director, Agriculture
- Commissioner, Food Safety
- Director General, Kerala Institute of Local Administration (KILA)
- DHS / NKKP State-level Nodal Officer in charge of One Health Programme
- Civil Society Representative

#### **At the District Level**

- **Chairperson:** District Collector
- **Convener:** District NKKP 2 Nodal Officer

#### **Members:**

- District Medical Officer (Health)
- Joint Director, Local Self-Government Department
- District Agricultural Officer
- District Animal Husbandry Officer
- District Fisheries Officer
- District Forest Officer
- District Food Safety Officer
- District Surveillance Officer
- Civil Society Representative

#### **At the Local Self-Government Level**

- **Chairperson:** Panchayat President / Municipality Chairperson / [Corporation Mayor]
- **Convener:** Medical Officer (PHC / FHC / CHC / TH)

#### **Members:**

- Panchayat / Municipality / Corporation Secretary
- Health Standing Committee Chairperson
- Concerned Departmental Officers of Local Self-Government

These committees must review the status of One Health activities at their respective levels and plan follow-up actions.

| <b>Committee</b>                      | <b>Review Meeting</b> |
|---------------------------------------|-----------------------|
| State Committee                       | Once in three months  |
| District Committee                    | Once in three months  |
| Local Self-Government Level Committee | Once in two months    |

In emergency situations, a meeting must be convened immediately.

### **Human Resource Empowerment Activities (Capacity Building)**

Human resource empowerment activities are another major component of the programme. Interventions to increase human resource capacity must be carried out at various levels to strengthen community-based disease surveillance and ensure early detection of problems. The Kerala Institute of Local Administration (KILA), on behalf of the Department of Health and Family Welfare, acts as the nodal agency providing support to plan and design capacity building activities for local self-governments and volunteers.

### **Communication Strategies**

Communication strategies have been planned to reach out to the public, create awareness about the importance of the One Health programme, and ensure active public participation. To deliver appropriate messages to people at various levels, different departments must collaborate to plan and implement this. In addition to these preparations, clear and appropriate information will be provided to public representatives and officials regarding this programme, the changes it will bring to society, and the opportunity it offers to become agents of social change.

### **System Strengthening**

To make disease diagnosis processes for humans and animals more accurate and effective, strengthening existing systems, equipping healthcare centres, and enhancing the capacity to analyse data in a way that enables appropriate decision-making at various levels and accurate responses are some of the key components of this programme. The programme is designed as a follow-up mechanism to precisely monitor the causes of disease outbreaks, analyse them, and ensure effective follow-up actions. An integrated, IT-based system is also highly essential for the implementation of the programme. To provide adequate support for programme implementation at the local government level in both cities and villages, the existing systems of local self-governments have been strengthened.

## **Session 4**

**One Health – Existing and to be implemented disease surveillance, diagnostic and intervention mechanisms within departments, community-based surveillance**

**Community-Based Surveillance**

Community-based surveillance is a process in which people systematically detect and report events of public health importance within their living environments. Improving the general public's capability to identify and report health problems helps in establishing better public health systems. There are mainly two methods in this system:

1. Indicator-Based Surveillance (IBS)
2. Event-Based Surveillance (EBS)

Disease surveillance refers to the continuous monitoring conducted at various levels regarding infectious diseases related to disease control and the circumstances under which they rapidly break out in the community. Effective disease prevention and control depend on this surveillance. Collecting, analysing, and interpreting the necessary data is a part of the surveillance process.



### **Indicator-Based Surveillance (IBS)**

Public health surveillance based on indicators is a traditional pathway for public health workers to report diseases. Indicator-based surveillance includes specific disease reports provided by everyone from healthcare providers to public health officials. Reports routinely recorded in a disease reporting database regarding the number of confirmed influenza cases from a hospital laboratory are an example of such information.

## **Event-Based Surveillance (EBS)**

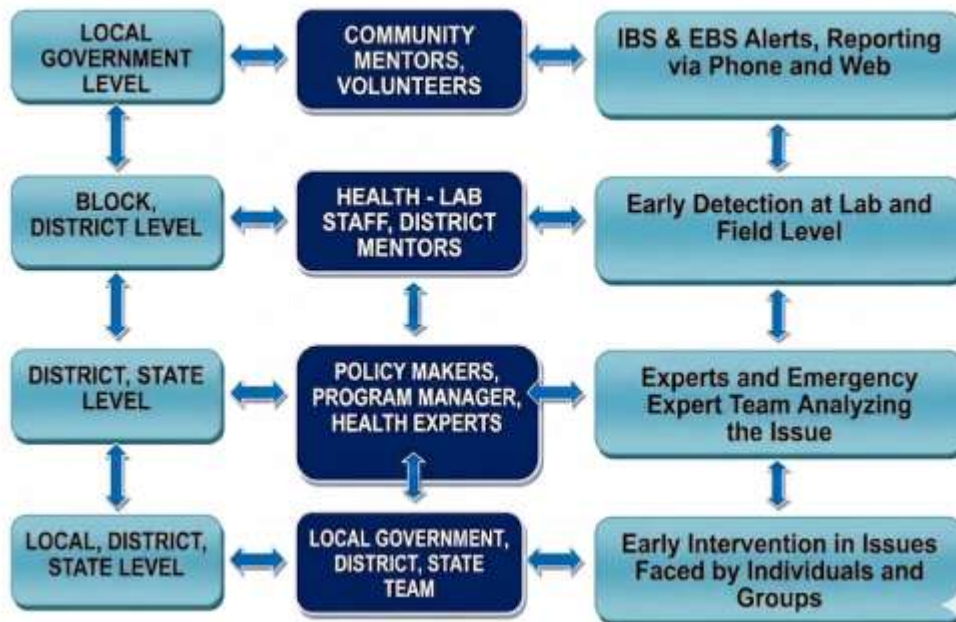
In event-based public health surveillance, reports, stories, rumours, and other information regarding unusual events that pose a serious threat to public health are examined. The objective of EBS is to detect unusual events that could indicate an infectious disease outbreak. Media reports and online reports are examples of sources from which EBS can collect information.

Information about events of public health importance can be reported by the public through a hotline system or other modern communication channels. In this way, EBS can be made more community based.

## **Main Objectives of Disease Surveillance**

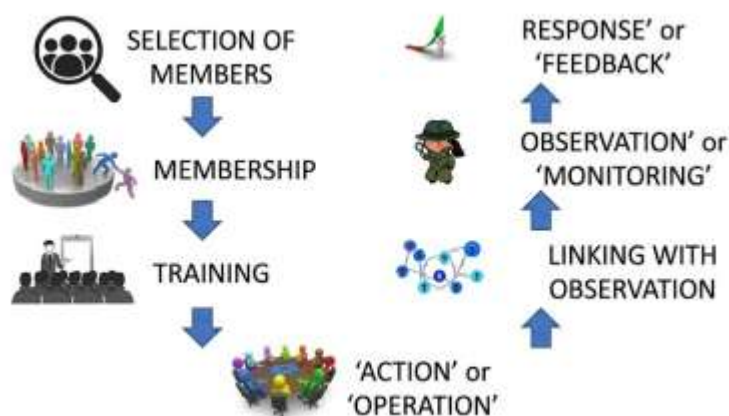
- Provide information regarding new and changing trends in the health status of the community. Eg: disease status, mortality rate, nutritional status, other indicators, environmental hazards, health practices, and other factors that may affect health.
- Provide feedback that helps revise policies and regulations in a manner that leads to the redefinition of goals.
- Provide timely warnings about public health disasters in a way that helps bring necessary modifications to intervention methods as required.

The role of the community is crucial in identifying, preventing, and responding to local problems that pose a threat to health, thereby improving the lives of millions of people worldwide. Effectively conveying changes and unusual events occurring in the health status of common people in a community to the authorities, and functioning primarily as the voice of the community, is one of the key benefits of community based disease surveillance. Through this communication method, it is possible to foresee the likelihood of infectious diseases and respond accurately. Consequently, it enables the prevention of infectious diseases before they spread.



As defined during the WHO Global Technical Meeting held in France in 2018, community-based surveillance is the systematic detection and reporting of public health events within a community by the members of the community themselves. Similarly, the community-based surveillance of the One Health Programme will be structured in the following manner:

1. It should be linked to a formal surveillance structure.
2. It must be action-oriented and time-bound.
3. It should be beneficial to the community.
4. There must be precisely defined reporting mechanisms.
5. It requires a feedback mechanism and a surveillance-review process.



To effectively implement the One Health Programme in Kerala, it is essential to establish a system that involves the public alongside existing formal surveillance systems. This will enable community members to utilize opportunities to monitor their surroundings, allowing for the early detection of and response to potential outbreaks or other events of public health importance in their localities.

### Implementation of the Programme in Kerala

In the initial phase, alongside the Rebuild Kerala Initiative, the One Health Programme is being implemented in the four Pamba river basin districts: Kottayam, Idukki, Pathanamthitta, and Alappuzha. It will later be expanded to the remaining 10 districts. The One Health Programme is being implemented in the state by utilizing the governance and management systems designed for the Nava Keralam Karma Padhathi-2.

The approach adopted in the One Health Programme considers not only human health but also the health of animals and the environment to conduct disease surveillance, detection, and interventions at various levels. By ensuring that systems designed at multiple levels function with utmost vigilance to identify or detect diseases transmitted from animals and other environmental sources, it will be possible to identify and address all health issues across humans, animals, and the shared environment.

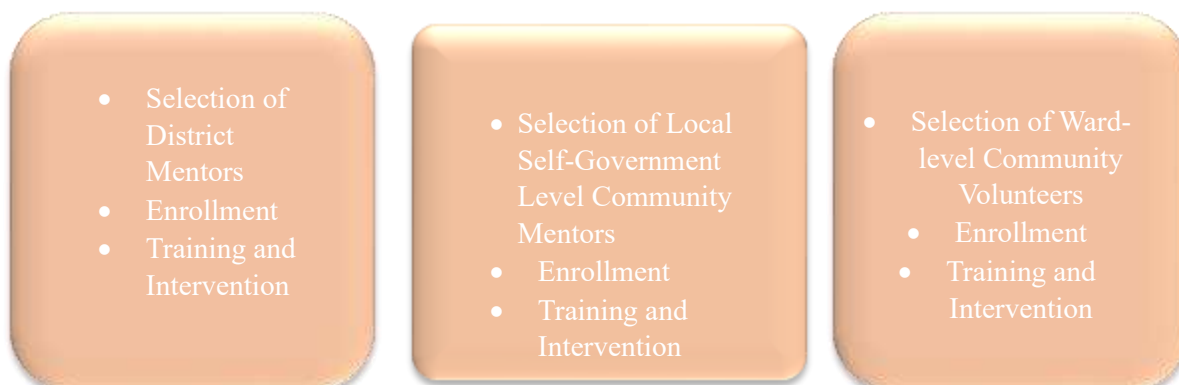
The details of the local self-governments (urban and rural) where the programme is currently being implemented are given below: *Source: - <https://dop.lsgkerala.gov.in/en/article/158>*

| District       | Grama Panchayats |       | Municipalities |       |
|----------------|------------------|-------|----------------|-------|
|                | Count            | Wards | Count          | Wards |
| Pathanamthitta | 53               | 788   | 4              | 132   |
| Alappuzha      | 72               | 1169  | 6              | 215   |
| Kottayam       | 71               | 1140  | 6              | 204   |
| Idukki         | 52               | 792   | 2              | 69    |
| Total          | 248              | 3889  | 18             | 620   |

### One Health Programme – District, Local Self-Government Levels

A three-tier programme has been planned in each district for the selection, training, and activities of community mentors and volunteers.

**Three-Tier System is monitored and supported by the DPSU**



### Mapping of Common Diseases in the Region and the Times of Their Occurrence (Seasonality mapping)

Disease mapping visually marks the geographical distribution of a disease within a residential area. It is a method used to determine the source of infectious diseases. Mapping studies based solely on the absolute number of cases rather than case rates can lead to incorrect conclusions. For instance, because a large number of people work or live in large industrial complexes, factories, or apartments, the number of cases there will naturally be higher. If other means are unavailable, information regarding population density and locations can be extracted from

census reports or satellite imagery. Environmental factors related to a region's geography and the host of the diseases play a major role in the outbreak of a disease in that area. Factors such as the presence of disease vectors, climate, population density, nutritional and dietary habits, occupation, recreational habits, economic development, and events causing social disruption like war and natural disasters are all examples of environmental factors.

Just like the location, the time when diseases are commonly reported is also highly important in disease mapping. This provides information regarding the seasonal changes that occur in diseases according to climatic variations such as rain and temperature. Collecting such data makes the planning of surveillance and preventive interventions highly efficient.

### **The Role of Laboratories in the One Health Programme:**

Kerala is one of the few states in the country with advanced disease diagnostic facilities. The role of laboratories is indispensable not only in confirming diseases but also in activities including antimicrobial resistance (AMR) surveillance, antimicrobial residue testing, food safety, and environmental safety monitoring. In the wake of new and re-emerging diseases and environmental disasters, the existing laboratory systems of the Health Department and other related departments need to be strengthened. Furthermore, laboratory facilities and the data available from these labs must be coordinated and shared in accordance with established criteria to ensure the earliest possible detection of diseases. The necessary protocols and platforms for this will be developed as part of the programme.

## What is Disease Surveillance?

Disease surveillance is the continuous monitoring of public health, alongside the continuous collection, analysis, and interpretation of health data, carried out to plan and implement public health protection initiatives.

## What are the Different Types of Disease Surveillance?

- **Active Surveillance:** This refers to the process of collecting data from hospitals, labs and other health facilities to monitor a specific disease or health issue or by visiting disease affected areas and collecting data / samples as part of a specific project. This method is laborious and requires precise planning.
- **Passive Surveillance:** This refers to the continuous monitoring of diseases from hospitals and labs. It is not part of any specific projects and is based on the data obtained from monthly or yearly reports. This is a surveillance method that can be implemented with relative ease.
- **Sentinel Surveillance:** Disease surveillance that is focused on a specific disease.
- **Community-Based Surveillance:** The systematic detection and reporting of events of public health importance within a community by the members of the community themselves.

## Main Components of Disease Surveillance



## Main Objectives of Disease Surveillance

- Provide information regarding new and changing trends in the health status of the community. Eg: disease status, mortality rate, nutritional status, other indicators, environmental hazards, lifestyles, and other factors that may affect health.
- Provide feedback that helps revise policies and regulations in a manner that leads to the redefinition of goals.
- Provide timely warnings about public health disasters in a way that helps bring necessary modifications to intervention methods as required. Plan interventions, act immediately.

## Existing Disease Surveillance Systems of the Health Department

The Integrated Disease Surveillance Program (IDSP) is a major component of India's public health efforts, designed to strengthen the country's capacity to detect and respond to disease outbreaks.

The primary objective of IDSP is to detect early warning signals of impending disease outbreaks and initiate rapid, effective responses to control their spread.

### Key Features:

- **Decentralized Surveillance:** IDSP operates through a decentralized system with surveillance units at district, state, and national levels. This structure facilitates a rapid flow of data.
- **Data Collection and Reporting:** It emphasizes the systematic collection, analysis, and interpretation of disease data using standardized reporting formats (S, P, L forms).
- **Laboratory Support:** Strengthening laboratory networks is a key component to ensure timely and accurate disease diagnosis.
- **Information Technology:** IDSP utilizes information technology for the collection, transmission, and analysis of surveillance data, enabling real-time monitoring.
- **Rapid Response Teams (RRTs):** Trained RRTs are deployed to investigate and control outbreaks, ensuring fast and effective interventions.
- **Training and Capacity Building:** IDSP includes training for healthcare workers at all levels to enhance their skills in disease surveillance and outbreak response.

### Importance of Surveillance:

- **Early Detection of Outbreaks:** IDSP plays a crucial role in the early detection of disease outbreaks and in minimizing their impact.
- **Time-bound Response:** By enabling rapid responses to outbreaks, IDSP helps control the spread of diseases, reducing morbidity and mortality rates.

- **Data-driven Public Health Decisions:** The program provides the data necessary for public health planning and decision-making, allowing for the implementation of targeted interventions.
- **Strengthening Public Health Infrastructure:** IDSP contributes to strengthening public health infrastructure, including laboratory networks and surveillance systems.

The Integrated Health Information Platform (IHIP) is the next-generation evolution of India's IDSP (Integrated Disease Surveillance Program), designed to overcome the limitations of its predecessor through modern digital technology. While IDSP established a decentralized system for time-bound outbreak detection via weekly reporting, IHIP provides real-time, case-based data collection through enhanced web and mobile platforms using extensive analytical tools, GIS (Geographic Information System), and dynamic dashboards. This ensures comprehensive data integration and an improved alert system, thereby significantly strengthening disease surveillance and outbreak response capabilities.

IDSP is vital in strengthening India's capacity to monitor and respond to public health threats, laying the foundation for further progress in disease surveillance through platforms like IHIP.

### **Disease Surveillance by Category (S, P, L Forms)**

In the context of India's Integrated Disease Surveillance Program (IDSP), 'S', 'P', and 'L' denote different types of surveillance reporting forms.

#### **Key Features of these Forms:**

- These forms serve as the focal point of IDSP's objective to monitor disease trends and ensure the early detection of outbreaks.
- The data collected through these forms assists public health officials in taking timely and appropriate measures to control and prevent the spread of diseases.
- These forms are used to generate weekly reports, which are subsequently utilized to track disease trends.
- In essence, these S, P, and L forms create a tiered surveillance system, wherein:
  - 'S' provides the broadest and earliest warning signal.
  - 'P' focuses attention on clinically suspected cases.
  - 'L' delivers the most accurate data regarding laboratory-confirmed cases.

#### **S (Syndromic):**

- Rather than diseases with a definitive diagnosis, this form captures information regarding syndromes or groups of symptoms.
- It is designed to detect early warning signs of potential outbreaks by tracking symptoms such as fever, diarrhea, or respiratory distress within the community.
- This form is also used to observe disease trends and achieve early detection.

**P (Presumptive):**

- This form captures cases where a diagnosis is made based on symptoms and clinical examination, without definitive laboratory confirmation.
- It is used for the investigation of diseases that have been clinically diagnosed.

**L (Laboratory):**

- This form reports information regarding laboratory-confirmed cases of specific diseases.
- It provides the most precise and definitive information regarding disease occurrences.
- This form delivers optimal data concerning diseases confirmed through laboratory testing.

**Community Based Surveillance**

Community-based surveillance is defined as the systematic detection and reporting of events of public health importance within a community by the members of the community themselves.

Two types of surveillance can be included in this:

- **Indicator-Based [IBS]** Based on specific indicators for each disease, conclusions are drawn, and factual reports are submitted to the health centre. This is a method for early detection. IBS will be conducted by those who have received training.
- **Event-Based Surveillance [EBS]** In addition to screening for diseases found unusually in a region, this method reports cases, deaths of animals, and outbreaks of diseases. This can be undertaken by social and voluntary workers.

**Objectives of Community-Based Surveillance**

- Improve the exchange of information between the community, primary healthcare systems, and various departments, and obtain early information regarding alarming health problems.
- Strengthen the community's disease surveillance capacity and the processes for detecting diseases.
- Utilize trained individuals and systems to conduct parallel surveillance of various diseases and problems.
- Enable mentors and community volunteers to report problem situations very rapidly.

**What is a Community Volunteer?**

- A person who provides services without expecting remuneration to bring about positive changes at various levels.
- Members can include Arogyasena workers, RRT members, employment guarantee scheme workers, Kudumbashree workers, Haritha Karma Sena members, NSS volunteers, etc.
- Volunteers will be listed by members/local self-governments with the assistance of mentors and subsequently connected with community surveillance systems.

### **What should Community Volunteers do?**

- Continuous monitoring of unusual events that could cause zoonotic diseases.
- Early detection of factors that could lead to zoonotic / vector-borne diseases
- Implementation of instructions received in return when reporting a disease status.
- House-to-house inquiries as required – constant contact with the community.

## **Department of Agricultural Development and Farmers' Welfare**

### **One Health Programme in Kerala**

The support and intervention of the Agricultural Department are indispensable for the successful implementation of One Health. The One Health approach can only be realized in Kerala by promoting agricultural activities aimed at food self-sufficiency and encouraging safe, environmentally friendly farming practices. Awareness activities must be conducted to sensitize farmers to the importance of the One Health approach when choosing fertilizers and pesticides, as well as when controlling pests, insects, and rodents.

Today, major issues in most parts of Kerala, such as infestations of African snails and rats, alongside attacks by wild animals, are very adversely affecting Kerala's agricultural sector. Similarly, we must view diseases transmitted from these types of creatures to humans with extreme gravity. We must handle diseases like leptospirosis spread by rats and cattle, and allergies and meningitis from African snails with great caution. Farmers themselves must become aware to inform the concerned officials as soon as possible if such infections occur in humans.

#### **Several Ways to Bring Rats Under Control**

- Organize rat eradication campaigns.
- Place various types of non-poisonous baits for the first three days. After that, on the fourth day, to attract more rats, mix 20 grams of Zinc Phosphide in one kilogram of bait and place it. This is an effective way to control rats.
- Placing a cut onion or black pepper powder inside or near their burrows, or sprinkling it, is a way to drive away rats.
- A small piece of banana or a piece of coconut can be hung in a trap and placed near their burrows at night to catch them.
- Placing 3–4 naphthalene balls in a small container in places where they are likely to come is a way to reduce the rat menace.
- Sprinkling baking soda at night in places where rats frequently visit will be beneficial in reducing their menace.
- It is also good to dip cotton in peppermint oil and place it in places where rats are likely to come. Rats cannot tolerate its pungent odour.
- The African snail, scientifically named *Achatina fulica*, also known as the giant snail, is a species belonging to the phylum Mollusca, class Gastropoda, family Achatinidae, and genus *Achatina*. In scientific records, these are described as the East African snail or the African giant snail. This snail, which breathes atmospheric air and lives on land, is a native of East Africa. They are an excellent example of an invasive species. They

have commonly established themselves in places like Asian islands, Indian Ocean islands, and the West Indies islands.

- They have invaded most tropical regions. They survive by swallowing and eating any part of plants. They even eat sand, bone, and concrete. Their attack destroys crops.
- They reach full growth in six months. They feed and move around at night. During the day, they remain hidden in the soil. They can live for five to ten years. In adverse conditions, they can go into hibernation (Aestivation/Hibernation) inside their shells for up to three years. Therefore, destroying them is not easy.

### **Methods to Control African Snails**

- Control methods must be adopted against them with public participation. Since the snail has a lifespan of 5 to 10 years, awareness campaigns to prevent the attack of snails can be organized at the ward/panchayat level. Collect snails one or two days a month during the evening from 6:00 PM to 8:00 PM. To attract snails, place wet gunny bags containing leaves of cabbage, cauliflower, or papaya around the area. Destroy the snails collected in this manner by putting them in salt water with a concentration of 10 to 20 percent (mixed at 200 grams of salt in 1 litre of water).
- The second method is to mix half a kilogram of wheat flour and 200 grams of jaggery into a paste, add 5 grams of yeast and 25 grams of copper sulphate for fermentation, and place it in small pots protected from rain. If attacks are seen on crops, it is highly desirable to spray Copper Oxychloride, a copper-mixed pesticide, mixed at 3 grams per 1 litre of water. If their attack is seen only on a very few plants, it is good to apply either bleaching powder, tobacco powder, or copper sulphate powder around the plants.
- The Kerala Forest Research Institute has informed that boiling 30 grams of tobacco in one litre of water and dissolving 60 grams of copper sulphate in one litre of water, then mixing these two solutions together and spraying, is very beneficial for controlling the snail. To prevent them from climbing on banana, arecanut, and coconut trees, apply 10% strength Bordeaux paste at the base. Use a pesticide like Metaldehyde only if the menace is severe. Their attack will not change with a single instance of control. Every year, before the start of the monsoon, such preventive measures must be adopted. Applying lime and copper sulphate around trenches where snails attack will help prevent them from migrating to other places.

## **Animal Husbandry Department**

### **One Health-Based Disease Surveillance, Diagnosis, Control, and Preventive Measures**

Disease surveillance is a continuous process that involves components such as the systematic collection, analysis, interpretation, and dissemination of data regarding diseases occurring between the public and animals, including their severity and mortality rate. Zoonotic disease surveillance simultaneously involves human and animal hospitals, laboratories, and epidemiologists.

Animal disease surveillance is designed with objectives such as providing warnings about potential risks, evaluating the effectiveness of intervention measures, identifying disease-affected areas, or determining freedom from infection. The baseline data obtained through such surveillance programmes provides sufficient evidence to evaluate disease eradication and control programmes.

Diagnostic laboratories identify disease-causing organisms through various tests or detect current and past diseases through antibody detection.

### **Community-Based Surveillance of Zoonotic Diseases**

Community-based surveillance is the process by which people systematically identify and report events of public health importance within their living environments. Improving the ability of common people to identify and report health problems helps establish better public health systems. There are two methods for this:

#### **a. Indicator-Based Surveillance**

Indicator-based surveillance includes specific disease reports provided by healthcare providers and public health officials. Reports routinely recorded in databases regarding the number of cases are examples of such data.

#### **b. Event-Based Surveillance**

This includes surveillance conducted on a community basis, centred around certain events that could occur prior to disease outbreaks. This type of surveillance helps detect early warnings of various diseases from within the community.

### **Other Disease Surveillance Methods**

- **Passive Surveillance**

This refers to the surveillance carried out by collecting data from reports submitted by hospitals and labs at the end of the month or year (not as part of any special projects) regarding diseases. This is a surveillance method that can be implemented effortlessly.

- **Active Surveillance**

This refers to the surveillance, where data is collected from hospitals, labs, and other health institutions to monitor a specific disease or health issue, or by visiting disease-affected areas as part of a specific project to collect samples. This requires effort and precise planning.

- **Community-Based Disease Surveillance** Farmer? Animal husbandry worker? Veterinary doctor? Epidemiology department? Analysis and feedback? Management decisions for preventing and controlling the disease.

- **Laboratory-Based Disease Surveillance (Laboratory-Based Surveillance)**  
Laboratory-based surveillance refers to conducting surveillance based on collecting samples, testing them in labs to find the exact causes of diseases, and arriving at a diagnosis.

Farmer/Animals? Samples and information? Laboratory results? Epidemiology department? Analysis and feedback? Management decisions for preventing and controlling the disease.

- **Syndromic Surveillance:** Surveillance conducted based on specific disease symptoms is called syndromic surveillance.

## **Prevention and Control Measures (Vaccination)**

### **Definition**

A vaccine is defined as a living or non-living microorganism or a part of a microorganism used as a preventive medicine to enable the body to resist an infectious disease.

When a pathogen enters a living body, the body's immune system recognizes it as a foreign substance and produces antibodies to destroy it. Subsequently, a memory of this pathogen is stored in the body's immune system. If infected by the same pathogen again, this remaining memory prepares the body to resist it quickly and strongly. This is the principle used in vaccination.

### **Vaccines Currently in Use**

Vaccines are manufactured in different ways for various diseases. Vaccines for a disease are prepared by using the pathogenic bacteria or virus itself.

**Based on production, vaccines can be mainly divided into two:**

1. Vaccines made using strains of pathogenic bacteria or viruses that have been altered to weaken their virulence, rendering them harmless/incapable of causing that disease, are called **"Live-Attenuated" (LIVE ATTENUATED)** vaccines.
2. Vaccines made by completely killing the pathogen are known as **"Inactivated" (INACTIVATED)** vaccines.

Apart from these, modern methods isolate only certain components present on the surface or inside of the pathogen to manufacture vaccines. The body's immune system recognizes these components and produces antibodies against the pathogen.

### Vaccination Schedule

| Sl. No. | Vaccine       | Animal to be Vaccinated | Vaccination Schedule                                                                                                       |
|---------|---------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1       | Rabies        | Dog, Cat                | First dose at 2–3 months of age. The next dose after 6 months, and then annually (once a year).                            |
| 2       | Anthrax       | Cattle                  | After six months of age. In areas where the disease is constantly reported, vaccination should be administered every year. |
| 3       | Brucellosis   | Calf                    | (Between four months and eight months of age).                                                                             |
| 4       | Leptospirosis | Dog                     | First dose at 2 months of age. The next dose after 6 months, and then annually (once a year).                              |

### Method of Handling

Vaccines are medicines that must be stored at a specific temperature after production. Depending on their type, they must be kept in a refrigerator or freezer until they are injected into animals. Storing vaccines at a temperature higher than the recommended one will very adversely affect their quality.

1. Vaccines instructed to be stored at refrigerator temperature should not be placed on the refrigerator door, in the vegetable tray, or directly below the freezer. These must be stored in the middle compartment of the refrigerator.
2. Frequently opening the refrigerator where vaccines are stored should be avoided. Ensure that the door of this refrigerator closes tightly.
3. The temperature inside the refrigerator must be visible from the outside and should be recorded in a register every day.

4. A generator or inverter can be relied upon to ensure continuous electricity supply to the refrigerator. The refrigerator door must not be opened during power outages.
5. It is preferable to store the vaccine in the refrigerator exactly in the way it was packed by the manufacturing company. Liquid vaccines must under no circumstances be placed in the freezer.
6. A thermometer should be placed in both the refrigerator and freezer where vaccines are stored to monitor the temperature.
7. All vaccines used in animals can be transported to other places at the recommended temperature without breaking the cold chain.
8. When transporting vaccines to distant places, care should be taken to carry them in a thermocol box with ice packing.

### **Matters to be Noted in the Field When Using Vaccines**

1. Non-reusable syringes and needles must be used for vaccination. These should be used only once.
2. Dehydrated vaccines (LYOPHILISED) must be dissolved in the recommended diluent before use. For this, the diluent must be cooled in the refrigerator before dissolving. The dehydrated vaccine in powder form is diluted in the cooled diluent to prepare it for injection. After dilution and until injection, the vaccine can be stored in a container filled with ice, away from direct sunlight.
3. Once diluted, vaccines must be used within two hours. Any vaccine remaining after that can be sterilized and disposed of according to instructions.

### **General Instructions**

1. It must be ensured that the vaccine brought to an institution has arrived at the correct temperature. For this, immediately upon the arrival of the vaccine, check the temperature inside the packed box. Immediately transfer the vaccine to the institution's refrigerator or freezer.
2. Vaccine vials must be protected from direct sunlight and other strong lights.
3. A register related to vaccines is necessary in all institutions. In this, the type, quantity, date of stock receipt, condition at the time of stock receipt, manufacturer's details, batch number, and expiry date of each vaccine must be recorded.
4. Instructions from the vaccine manufacturers must be strictly followed. The information recorded on the vaccine label must be read and understood completely.
5. It is always essential to ensure that the institution's refrigerator and freezer are functioning properly. For this, periodic servicing must be conducted without fail.

| <b>Animal Husbandry Department</b>                                |                                                                        |
|-------------------------------------------------------------------|------------------------------------------------------------------------|
| <b>Disease Investigation, Diagnosis, Control &amp; Prevention</b> |                                                                        |
| •                                                                 | Network of Laboratories (SIAD - RDDs - District Clinical laboratories) |
| •                                                                 | SADEC (State Animal Disease Emergency Control Room) – 24X7             |
| •                                                                 | Animal Disease Control Project (ADCP) :                                |
| •                                                                 | • Project Co-ordinator & District Co-ordinators                        |
| •                                                                 | Epidemiology Wing :                                                    |
| •                                                                 | • State Epidemiologist & District Epidemiologists                      |
| •                                                                 | Institute of Animal Health & Veterinary Biologicals                    |
| •                                                                 | State Laboratory for Livestock Marine & Agri Products                  |

## **Forest - Wildlife Department**

### **Community-Based Disease Surveillance**

As far as domestic animals are concerned, their unusual behaviour can be seen as an early symptom of illness, allowing for timely treatment and care. However, changes in the natural behaviour of wild animals are usually not noticed by humans. According to the One Health concept, to protect human health, it is necessary to observe abnormalities occurring in the behavioural patterns of wild animals and take the necessary steps to deal with subsequent health problems.

Training is provided to individuals who live near or close to forest areas to identify abnormal reactions in animals and to report such information for scientific testing. Through this, steps can be taken to detect and resolve health issues in wild animals early. In addition, this helps create an environment where biodiversity is preserved, and humans can coexist peacefully with wildlife.

Continuous surveillance and management are essential to protect the health of wildlife, preserve the environment, and prevent the transmission of zoonotic diseases from them to humans and domestic animals.

## **Irrigation Department**

The mandate of the department is to provide irrigation necessary for agriculture. In addition, the operations of this department include activities to tackle coastal erosion, systems to prevent saltwater intrusion into paddy fields, and flood control by removing mud and silt from rivers

and streams and constructing embankments. Under the Irrigation Department in Kerala, there are 16 dams, 44 rivers, and numerous backwaters, ponds, and canals.

Dams, check dams, VCBs (Vented Cross Bars), and RCBs (Regular Cum Bridge) are constructions of this department. Excess water during the rainy season can be stored and used for irrigation as needed during the summer.

The Water Conservation Act envisages an act to consolidate and amend the laws related to the construction of irrigation works, to improve the conservation and distribution of water for irrigation, to ensure the contribution and water cess on lands benefiting from irrigation works in the State of Kerala, and to ensure farmers' participation in matters related to water utilisation systems and related matters.

Waterborne diseases can be prevented to an extent if water pollution activities, such as waste dumping into dams, rivers, streams, ponds, reservoirs, and canals under the control of the Irrigation Department, are identified early. Continuous surveillance and regulations are essential for this. For this purpose, places where waste dumping occurs extensively must be identified and strict measures must be taken. To identify these, skilled and casual workers and labourers of the department can be trained and assigned to report incidents like waste dumping and encroachments, etc. Further action can be taken based on the information they provide.

Encroachment and waste dumping in water bodies can be cleared, and further measures can be taken, only with the cooperation of other departments (Local Self Government Department [LSGD], Pollution Control Board [PCB], Revenue). For this, a detailed study of the Water Conservation Act and Panchayat Raj Act is necessary. If encroachment is detected, it should be reported to the Revenue authorities. If waste dumping is found in water bodies, the local self-government authorities should be informed, and they will issue notices to those who dump the waste. Apart from this, to prevent the dumping of household and commercial waste into water bodies, the LSGD issues notices, installs fencing in areas prone to high waste dumping, and sets up surveillance cameras. Moreover, the pollution in 9 rivers notified by the Government of Kerala (Bharathapuzha, Chaliyar, Pamba, Kallada, Periyar, Vamanapuram, Chandragiri, Karamana, Meenachil), encroachments within the scope of the Irrigation Department's projects can be cleared by the department itself by issuing notices.

The intervention of departments like the Kerala Water Authority and the Pollution Control Board is also essential to inspect whether the use of pesticides in agricultural lands is polluting the water sources.

## **Drugs Control Department**

The enforcement wing of the Drugs Control Department implements the provisions of rule-65 of the Drugs and Cosmetics Act to ensure the safety (supply chain security) and quality standards of medicines for the general public. If violations of the law are found, strict departmental and legal actions are taken. To prevent the illegal sale of medicines, officers inspect records to ensure that medicines are purchased and sold only from licensed

establishments. Through this, it is possible to track down and prevent the illegal sale of antibiotics and related medicines to other sectors (agriculture, veterinary, fisheries). Ensuring the quality of medicines is essential for effective treatment. Drugs Inspectors regularly collect samples of medicines from hospitals (government, private, clinics) and wholesale/retail pharmacies, and send them to the Drugs Testing Laboratories for quality analysis. Legal action is taken to completely ban the sale of medicines declared as not of standard quality and to recall them from the market.

Inspecting medical shops ensures that antibiotics are sold accurately only against prescriptions. This helps prevent illegal sales. Ensuring the presence of a registered pharmacist in medical stores provides the public with accurate information regarding the dosage of medicines, their expiry dates and self-medication will be prevented.

### **Antimicrobial Resistance Prevention Activities of the Drugs Control Department**

The Drugs Control Department has formulated and is implementing various action plans across the state to prevent antimicrobial resistance.

The "Antimicrobial Resistance" prevention activities of the Drugs Control Department are listed below:

1. Operation AMRITH (AMRITH-Antimicrobial Resistance Intervention for Total Health)
2. ROAR (ROAR-Rage On Antimicrobial Resistance) Program
3. Operation Vetbiotic
4. Operation Double Check
5. SPAARK (Students Programmes Against Antimicrobial Resistance Kerala)
6. PROUD (Programme for Removal of Unused Drugs)

#### **1. Operation AMRITH**

To combat the massive threat of antimicrobial resistance, the Drugs Control Department is one of the departments playing a decisive role in achieving the government's declared goal of 'Antibiotic Literacy'. To prevent the over-the-counter sale of antibiotics without a doctor's prescription from pharmacies in the state, the department launched a new project on 06.01.2024 named 'Operation AMRITH' (OPERATION AMRITH – Anti Microbial Resistance Intervention for Total Health).

A system to receive complaints directly from the public via the department's toll-free number (1800 4253 182) has also been included in the Operation AMRITH project. Through this, the department aims for a combined operational approach uniting the public and the Drugs Control Department for resistance control. The official designated to receive complaints records them on a Google Spreadsheet and forwards them to the Assistant Drugs Controller of the Intelligence Branch for investigation. The Assistant Drugs Controller (Intelligence Branch) hands over the complaint to the Drugs Inspectors of the Intelligence Wing of the respective

regional offices for investigation, and upon receiving the Drugs Inspector's report, the Drug Controller initiates departmental actions.

Department officials are continuously conducting inspections at medicine sales outlets across the state to detect the sale of antibiotics without a prescription. Following Operation AMRITH, social media news reports indicated a decline of ₹1,000 crores in the sale of antibiotic medicines in the state. Subsequently, survey studies conducted by the department regarding this estimated a decline of around ₹300 crores in the sale of antibiotic medicines.

## **2. ROAR (Rage on Antimicrobial Resistance) Program**

Following Operation AMRITH, as part of the ROAR (Rage On Antimicrobial Resistance) program to further control the sale of antibiotics, the Drugs Control Department has distributed blue envelopes exclusively for the sale of antibiotics to all drug stores to prevent the sale of antibiotic medicines without a doctor's prescription. The department has taken this measure primarily to raise awareness and emphasize the importance among the public that medicines they are taking are antibiotics.

## **3.Operation Vetbiotic**

Operation Vetbiotic is another prevention campaign implemented by the department as part of preventing the unscientific use of antimicrobial drugs in veterinary fields and food supplements in the veterinary sector. It has been observed that antibiotics belonging to Schedule H and H1 are being used in farms and animal feeds distribution without any standards. Following inspections conducted in over 73 establishments across the state, including pet shops, farms, and veterinary medicine selling medical stores, legal actions were taken against the violations found, which included the sale of antibiotic medicines mixed into food supplements without any license standards. Products worth approximately Rupees 2 lakhs were seized. Furthermore, testing conducted on samples collected from such feed products at the Drugs Testing Laboratory confirmed the presence of antibiotics.

## **4. Operation Double Check**

Following the introduction of GST, traders buy medicines directly from manufacturers rather than from company depots, created an opportunity for spurious medicines to enter the state market. During testing of medicine samples, some cases of spurious/ counterfeit medicines were found. Following this, to track down the supply chain of medicines, including antibiotics, the department has launched a special programme called “ Operation Double Check”. Under this program, Drugs Inspectors randomly collect a minimum of 5 medicine samples from each medical store and collect purchase records to trace the manufacturer's details. Penalties are imposed for failure to produce purchase bills without the correct batch number and expiry date.

## **5. SPAARK (Students Programmes Against Antimicrobial Resistance Kerala)**

Through the 'SPAARK' project, the Drugs Control Department aims to raise awareness among the public, utilizing the capability of students to spread the message regarding the dangers of unscientific drug use in the modern world. The Drugs Control Department, in collaboration with the National Service Scheme (NSS), has also successfully implemented the 'SPAARK Sougyam Sadha' project. In the project initiated in December 2024, nearly thousands of VHSE, NSS, and NHMAS student volunteers conducted surveys in households across 343 Panchayats under the framework of the Drugs Control Department's SPAARK project, and carried out awareness activities regarding unscientific drug use, the adverse effects of excessive antibiotic use, and effective methods to prevent antimicrobial resistance.

### **IEC Activities of the Drugs Control Department**

As part of preventing antimicrobial resistance, the department organized several awareness programs across the state during the 2023–2024 period for registered pharmacists, drug merchants, and students. The Drugs Controller has given strict instructions to all pharmaceutical business establishments to display a warning stating that Schedule H and Schedule H1 drugs, including antibiotics, will not be sold without a doctor's prescription. The department has also issued warnings to all medical shops to display awareness posters regarding the health risks associated with self-treatment and the sale of antibiotics without a prescription.

Furthermore, as part of preventing the sale of antibiotics without a doctor's prescription and bringing greater control over the sale of such medicines, the sale of antibiotics must be carried out in blue envelopes. The department has taken this measure to create awareness and emphasize among the public that the medicines they consume are antibiotics.

### **7. PROUD (Programme for Removal of Unused Drugs)**

The careless disposal of expired and unused medicines into the soil and water bodies contributes to antimicrobial resistance and environmental pollution. Since there are currently no adequate system in the country to collect or scientifically dispose of such medicines, a situation exists where the public discards unused and expired medicines in an irresponsible manner.

To combat the global threat of antimicrobial resistance, the Drugs Control Department has formulated and is implementing various action plans. Several studies indicate that the unscientific disposal of unusable medicines leads to environmental pollution. Based on such studies, unused medicines must be disposed of scientifically as per the Bio – Medical Waste Management Act & Rules. To address the serious issue of anti-microbial resistance this is important. To raise awareness among the public and to collect unused and expired medicines from the public for scientific disposal, the Drugs Control Department, in collaboration with the

drug merchants' association, All Kerala Chemists and Druggists Association (AKCDA), launched a project named PROUD in 2019. With the approval of the government, this project was implemented in the state on a pilot basis in Thiruvananthapuram district. Unused medicines are collected from the public through medicine drop boxes/collecting bins placed for this purpose at various medical stores in the district, and are scientifically disposed of through a waste management plant operating at Mangalapuram with the approval of the Central Environment Department.. Accordingly, during the 2019–2020 period, approximately 5.5 tons of unused medicines were scientifically disposed of through the PROUD-I and PROUD-II projects.



### **New Programme for Removal of Unused Drugs (nPROUD)**

Following the excellent cooperation received from the public for the PROUD project, and as part of expanding this project across the state, the Drugs Control Department has launched a modified initiative introducing necessary changes to the existing project, named the New Programme for Removal of Unused Drugs (nPROUD). Kerala is the first state in the country to formulate and implement such a project at the government level.

This project primarily aims to collect unusable medicines through three different methods:

1. In designated months, the Haritha Karma Sena or any other self-help group selected by the local self-government institutions will visit each household according to their operational calendar and collect unusable medicines. For this purpose, when handing over the medicines, they must be separated into solid substances, liquid substances, and medicines containing flammable substances.
2. More importantly, the public can deposit unusable medicines into the blue-coloured boxes set up at permanent collection sites, known as Drug Take Back Centres, at the

ward level. At the end of the month, workers from self-help groups will collect the medicines from these boxes. Details regarding the permanent collection sites in each area will be made available on the official website of the Drugs Control Department.

3. Unusable medicines from wholesale/retail business establishments and clinics operating on a commercial basis must be brought to designated collection centres. There, they must be handed over to the project operators after calculating the weight and paying a fixed fee. The days designated for this purpose will be observed as "Go Blue Day" for antimicrobial resistance prevention campaigns.

Medicines collected in this manner will be scientifically disposed of at the waste management plant of Kerala Enviro Infrastructure Limited (KEIL), which operates with the approval of the Central and State Environment departments. The pilot study of the project commenced on 22.02.2025 in Kozhikode Corporation and Ulleri Panchayat in Kozhikode district. Subsequently, this project will be implemented across the state.

### **Future Plan**

**MEDWATCH**

The use of sub-standard antibiotic medicines leads to an increase in antimicrobial resistance. Furthermore, the use of such medicines can also cause serious health problems. MEDWATCH is envisioned as a mobile application to ensure whether the medicines used by each individual maintain quality standards. For this purpose, after making this application functional on a mobile phone, the name of the medicine and the batch number should be provided as INPUT. After gathering information from the data stored in the department's database, information regarding the quality of the medicine will be received as a message on the registered mobile number within a split second.



### **Sentinel Pharmacies**

The type and quantity of medicines sold heavily in the market are indicators of the disease status in society. Sentinel pharmacies are a permanent mechanism to collect details of medicines, especially specific medicines, used in the state. For this purpose, accreditation is granted to selected pharmacies in the state, and subsequently, training is provided to the registered pharmacists of the aforementioned establishments to collect data. The information collected in this manner is gathered in the centralized system of the Drugs Control Department and handed over to the government for future operations.

This is the first program of its kind in the country. Sentinel pharmacies will function as a major cooperative partner of the Drugs Control Department in key operations including post-marketing pharmacovigilance, drug take-back programs that are part of PROUD, and price monitoring. Sentinel pharmacies will act as frontline warriors of the Drugs Control Department to ensure strict vigilance against the influx of counterfeit medicines and the misuse of antibiotic medicines. Through this, excellent interaction, coordination, and relationship with the public can be achieved. It is possible to determine antibiotic quantities (Antibiotic Metrics) through sentinel pharmacies

## **Fisheries**

To effectively handle the health and disease prevention of fish, it is crucial to understand the biology of the organism, its environmental surroundings, and the causes of diseases. An understanding of these aspects helps eliminate the sources of infection or prevent its spread. Improving the health of fish is essential to resist infection. Complying with effective quarantine guidelines and health certification procedures reduces the possibility of disease occurrence and transmission. Along with developing a scientific and efficient disease reporting system starting from the farm level, comprehensive disease surveillance can be ensured by establishing health data monitoring systems with farmers' participation at district and state levels. An early warning

and forecasting system are also necessary to control disease spread. Furthermore, improved basic infrastructure and trained human resources are vital for effective aquatic animal health management.

The aquatic environment is constantly changing. When water quality deteriorates, it causes stress to the fish, which often leads to the spread of disease. To maintain the quality parameters of water at the correct levels, regular monitoring of temperature, dissolved oxygen levels, ammonia, pH, hydrogen sulphide, suspended solids, and alkalinity at precise intervals is essential. Early detection and rapid response are required to control the spread of diseases. An effective surveillance program is indispensable to ensure this. The surveillance and reporting of diseases in aquatic organisms occur at various levels. Right from the onset of a disease, a prompt and effective response from all the following levels is essential.

## **1. Farmer Level**

### **i. Steps to be taken in a situation where the daily mortality rate is less than 0.3%:**

- Check water quality parameters; observe the aquatic organisms for any abnormal movements, swimming patterns, or other behavioural changes; check feed consumption; record details in the Farm Health Card.

### **ii. Steps to be taken in a situation where the daily mortality rate is between 0.3% to 0.5%:**

- Check water quality parameters twice a day; repeatedly observe if there are abnormal movements or other behavioural changes; inspect the fish for any physical deformities; check and adjust feed consumption accordingly.
- Inform a clinical practitioner within 24 hours, record details in the Farm Health Card.

### **iii. Steps to be taken in a situation where the daily mortality rate exceeds 0.5%:**

- Immediately report to a clinical practitioner.
- Close the inlet and outlet water supplies of the farm; stop feeding and all other activities on the farm.
- If possible, isolate the remaining fish into another spare pond or tank.
- Continuously observe for any abnormal movements, behavioural changes, or disease symptoms.
- Collect samples and send them directly from the farm to the laboratory.
- Do not destroy or discard dead fish until proper samples have been collected for investigation.
- Wait for diagnosis and further instructions from the clinical practitioner.
- Do not sell or discard any fish without the consent of the clinical practitioner.

## **2. Clinical Practitioner Level**

### **I. Passive Surveillance (in a situation of a suspected disease/disease outbreak)**

- Visit the site and conduct a disease examination within the shortest possible time.
- Observe the farm and its surroundings to find the source of any disease spread.
- Check the Farm Health Card.
- If any infection is suspected, immediately inform the district authority.
- Ensure that water is not being discharged into public water bodies.
- Ensure that feeding and all farm activities are stopped.
- Ensure that no fish is sold or discarded without the consent of the clinical practitioner.
- Ensure that all possibilities of the disease spreading from the farm are minimized.
- Ensure that details have been recorded and that data is compared with collected records.
- Diagnose the disease/problem based on the preliminary investigation and initiate containment measures.
- If the farmer has sent samples directly to a lab, ensure a detailed diagnosis report is obtained as quickly as possible.
- Accurately diagnose the disease/problem and communicate additional details to the farmer.
- Initiate appropriate treatment based on the diagnosis, or give instructions for farm isolation, harvesting, or destruction of stock.
- Antibiotic use to control the disease should be initiated only if a bacterial infection is medically confirmed.
- Inform neighbouring farmers.
- If an infection is medically confirmed, report to the district team along with the action-taken report.
- If the clinical practitioner has not reached a conclusion, immediately refer the matter to the district-level team for further investigation.
- Safely destroy the infected stock and properly disinfect the water and farm surroundings.
- If a large-scale disease outbreak occurs, report it directly to the state-level committee.
- Maintain all records of the measures taken for future reference and data collection.
- Closely monitor the farm for any future outbreaks and ensure BMP (Better Management Practices).

## **II. Active Surveillance (When there is no disease outbreak)**

- Collect samples from selected farms.
- Conduct PCR testing for diagnosis of diseases including NNV/TiLV/CEV/CyHV-2/EUS for finfish, and AHPND/WSSV/IHHNV/HPV/MBV for shellfish.
- Determine the load of *Aeromonas* species/*Streptococcus* species in the case of finfish, and *Vibrio* species load in the case of shellfish.
- Conduct residue analysis for Chloramphenicol, Tetracycline, and Nitrofurans using ELISA or LC-MS.
- Conduct water analysis for Dissolved Oxygen, pH fluctuation, Hardness, Salinity, Nitrate, Nitrite, Ammonia (Un-ionized, Unionized), Hydrogen Sulphide, Iron, etc.

- Conduct feed analysis to evaluate Crude Protein, Digestible Nitrogen, Fat, etc.
- If any problem is found, inform corrective measures and the lab report strictly to the farmer.
- Submit the response report to the district-level committee.

### **3. Laboratory Level**

- Analyse samples in accordance with guidelines (Standard Operating Procedure); provide the disease diagnosis report as quickly as possible to the sender of the sample (Farmer/Clinical Practitioner).
- If a farmer sends a sample directly, immediately inform the related clinical practitioner if it is a case of disease surveillance; ensure proper preservation of the sample for future analysis.

### **4. District Level**

#### **1) District-level intervention to report a more detailed investigation:**

- Upon receiving information regarding a disease outbreak, the district surveillance team must visit the farm within the shortest possible time.
- Review the preliminary investigation report and check the corrective measures taken.
- Compare the received details and data with the available data collection; if necessary, conduct a secondary investigation. Recommend corrective measures based on the conclusions.
- If a conclusion cannot be reached at the district level, immediately refer the matter to the state committee.

#### **2) District-level intervention to report information in a time-bound manner:**

- Ensure a time-bound disease diagnosis report from the lab and conduct a site visit if necessary.
- Closely monitor all measures taken to control the disease spread.
- If it is an outbreak, issue warnings to the farmers in the district through audio-visual social media.
- Maintain all records of the actions taken for future reference.
- Maintain a data repository at the district level.
- Report the clinical diagnosis and the measures taken to the state level.
- Submit a monthly report to the Director of Fisheries regarding the disease outbreak in the district.
- Convene an interactive communication meeting once every six months with farmers and other related departments.
- Prepare a list of the aquatic animal diseases predominantly found in the district.

### **5. State Level**

Liaise with KUFOS, ICAR, and other institutes to select the correct preventive measures.

## **Environment Sector**

### **Monitoring / Findings**

#### **1. Directorate of Environment and Climate Change (DoECC)**

##### **Assessment of the State's Greenhouse Gas Emissions**

##### **1.1 State Level**

Based on the State Government's declaration to achieve the goal of net-zero carbon emissions by 2050, and to formulate an action plan as well as streamline the necessary measures for it, the State Government constituted a Working Group vide 8.0 (Rt) No.B/202 VENV dated 10.01.2021. Subsequently, with the approval of the government (No. 262/B/2022/Envvt dated 31.10.2022), the Directorate of Environment and Climate Change (DoECC) signed a Memorandum of Understanding (MoU) with the Sudha Foundation, a policy research institute working in this field, to determine the greenhouse gas emissions of the state according to

internationally accepted methods and to formulate an action plan to achieve the goal of carbon neutrality. The Directorate of Environment and Climate Change (DoECC), in coordination with all the key partner departments/ agencies of the state, has assessed the emissions of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) from five key sectors namely energy, Industrial Processes and Product Use (IPPU), Land use, Land use change, and Forestry (LULUCF), Agriculture, and Waste for the period of 2005 to 2021 and prepared a detailed report on the same. The web portal prepared by the Directorate incorporating the said information was launched by the Hon. Chief Minister on 5<sup>th</sup> June 2024. In addition, a draft action plan to achieve the state's target of becoming net-zero carbon neutral by 2050 has currently been prepared. The Directorate of Environment and Climate Change is taking necessary steps to finalize this plan.

## **1.2 Methodology**

The greenhouse gas (GHG) emission estimation for the state has been conducted based on the internationally accepted methodology published by the Intergovernmental Panel on Climate Change (IPCC), an international body on climate change. All greenhouse gases emitted in Kerala during the period from 2005 to 2021 were included in this emission inventory. The data required for this was sourced from the relevant departments of the State Government, as well as national-level agencies such as the Central Electricity Authority and the Ministry of Petroleum and Natural Gas.

The emission estimation was carried out based on the classifications followed by the Government of India (NATCOMS, BUR) in line with IPCC guidelines (IPCC 2006; IPCC 2019). It covers the five major sectors and their sub-sectors responsible for greenhouse gas emissions are Energy, Industrial Processes and Product Use (IPPU), Land Use, Land-Use Change, and Forestry (LULUCF), Agriculture, Waste.

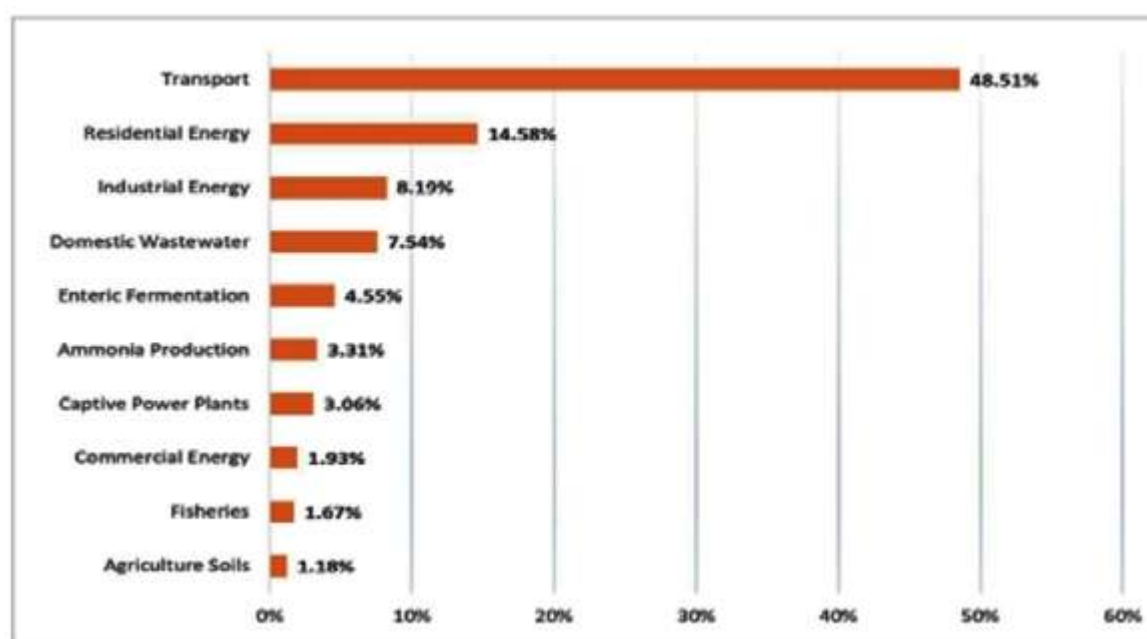
## **1.3 Key Insights**

The Energy sector has been identified as the highest contributor to greenhouse gas emissions in the state. In 2021, the state's total gross greenhouse gas emissions stood at 21.86 MtCO<sub>2</sub>e (Metric Tonne Carbon Dioxide Equivalent). However, in 2005, this figure was 23.46 MtCO<sub>2</sub>e. Between the period of 2005 and 2021, there has been no significant variation in gross emissions. Nevertheless, the highest volume of emissions was recorded in the year 2019, at 24.53 MtCO<sub>2</sub>e.

Kerala is a state with 29.65% forest cover. Furthermore, according to the India State of Forest Report (ISFR, 2021), there has been an increase in Kerala's forest cover, including tree cover outside protected forest areas. This has helped maintain the state as a major carbon sink and aided in carbon removal (sequestration). Consequently, it is estimated that 10 MtCO<sub>2</sub>e of carbon was removed in the year 2021.

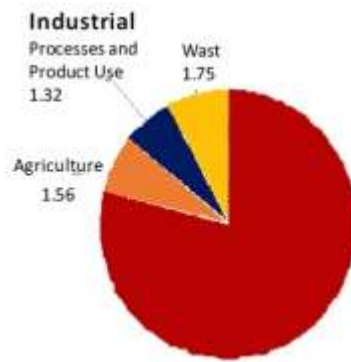
According to 2019 data, the national average for annual per capita greenhouse gas emissions was 2.46 MtCO<sub>2</sub>e, whereas Kerala's annual per capita emission was significantly lower at just 0.41 MtCO<sub>2</sub>e. In 2021, the energy sector stood out as the primary contributor by generating 79% of the state's total emissions, driven heavily by its transport sub-sector which alone accounted for 49% of all state emissions, with road transport making up 91% of that share. Residential energy consumption formed another major part of the energy sector by causing 19% of the state's total emissions, while the waste sector was identified as the second-largest source overall, responsible for 18% of total emissions amounting to 1.75 MtCO<sub>2</sub>e due to the combined impact of solid waste and domestic wastewater.

#### 1.4 Major Sectors and Greenhouse Gas Emissions (%) (2021)

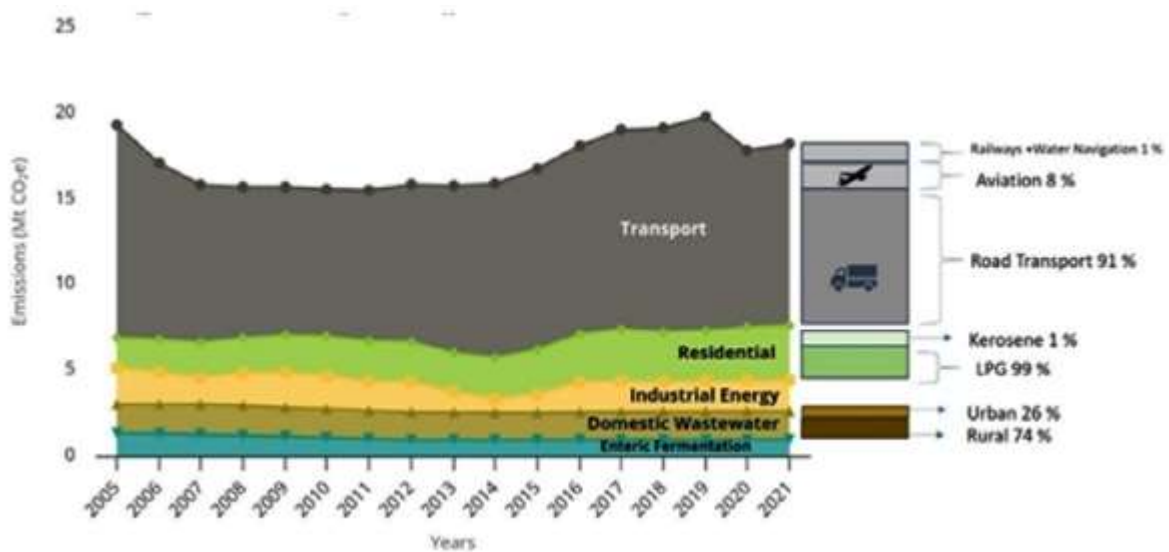


In terms of greenhouse gas emissions, Kerala's Agriculture sector ranks third, contributing 1.56 MtCO<sub>2</sub>e (approximately 7% of the state's total) in 2021, a figure that is tenfold lower than the energy sector primarily due to a 7% reduction in Net Cropped Area and a sharp 39.84% drop in wetlands and paddy fields compared to the 2002–03 baseline. Because of this shrinking cultivation footprint, agricultural greenhouse gases are driven predominantly by the livestock-related enteric fermentation sub-sector rather than direct crop farming. Meanwhile, the Industrial Processes and Product Use (IPPU) sector ranks fourth, generating 1.32 MtCO<sub>2</sub>e (around 6% of the state's total volume) in 2021; despite facing certain data limitations during mapping, these findings highlight a critical and urgent need to establish targeted decarbonization policies that can transition chemical and mineral-based industries toward low-emission industrial processes.

#### Greenhouse gas emissions from various sectors ( MtCO<sub>2</sub>e)



### Major Emission Categories and Their Trends



The state's greenhouse gas (GHG) emission profile detailed above provides clear strategic direction for defining the exact policies and interventions needed to combat climate change. Foremost among these is targeted mitigation within the energy sector—specifically transport and residential energy use—which collectively command 49% of the state's entire carbon footprint. Systematically reducing these, alongside emissions from other heavy sectors like waste management and Industrial Processes and Product Use (IPPU), will steer the state smoothly toward its goal of achieving Carbon Neutrality by 2050. According to projections in the State Action Plan on Climate Change (SAPCC 2.0), Kerala's vehicular population is estimated to reach staggering heights by 2030, including 20 million two-wheelers, 600,000 autorickshaws, 10 million cars, and 150,000 buses. Given these explosive growth trajectories, introducing cutting-edge operational frameworks and policy updates to curb transit emissions is vital. To scale up public transit efficiency, the 14th Five-Year Plan actively envisions integrated multimodal transport networks, heavily mirroring successful models like Kochi's unified framework that syncs electric buses, the Metro rail, and Water Metro systems. Furthermore, optimizing the state's vast network of inland waterways and adopting solar-powered passenger boats will significantly alleviate pressure on road networks, directly

shrinking transit sector emissions. Concurrently, adopting modern, scientific waste processing technologies will unlock dramatic emission cuts in the second-largest sector. This must be backed by state-wide, aggressive energy efficiency regulations. True carbon neutrality is realized only when the volume of greenhouse gases emitted into the atmosphere is perfectly balanced by the volume safely absorbed and sequestered by our carbon sinks.

All the aforementioned data has been compiled into a dedicated web portal, which is accessible on the department's website via the link: <https://climatechange.envt.kerala.gov.in>.

## **2. Kerala State Pollution Control Board (KSPCB)**

The Kerala State Pollution Control Board is the regulatory authority responsible for ensuring compliance with the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, and the Environment (Protection) Act, 1986. Several critical statutory frameworks operate under the overarching Environment (Protection) Act, including the Solid Waste Management Rules, 2016, the Bio-Medical Waste Management Rules, 2016, and the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. The Board strictly enforces pollution control measures across all industrial and commercial establishments falling within the ambit of these regulations by issuing official Consents, Authorizations, and Registrations.

Mandatory clearance from the Board is required for factories, hospitals, restaurants, and large-scale residential buildings exceeding specified built-up area thresholds. Similarly, Local Self-Government Institutions (LSGIs) must obtain explicit authorization from the KSPCB to run their solid waste processing facilities. Furthermore, any establishment generating or handling electronic waste (e-waste), plastic waste, construction and demolition (C&D) waste, battery waste, biomedical waste, or hazardous waste automatically falls under the Board's regulatory oversight. Alongside ensuring scientific waste management, the Board continuously monitors effluent quantity as well as ambient air and water quality benchmarks. To support these regulatory duties, the KSPCB operates 16 field offices equipped with testing laboratories—comprising three units in Ernakulam district and one in each of the remaining districts. Operational governance is streamlined through three regional offices based in Thiruvananthapuram, Ernakulam, and Kozhikode, alongside a centralized apex laboratory working out of Ernakulam.

### **Major Initiatives and Activities**

- Monitoring Programme
- National Water Quality Monitoring Programme (NWMP): 200 stations
- State Water Quality Monitoring Programme (SWMP): 138 stations
- National Ambient Air Quality Monitoring Programme (NAMP): 34 stations
- State Ambient Air Quality Monitoring Programme (SAMP): 6 stations

- Continuous Ambient Air Quality Monitoring System (CAAQMS): 9 stations
- Tracking and identifying active pollution sources across regions by conducting field-level sanitation surveys via a dedicated mobile application.
- Deploying specialized environmental surveillance and monitoring protocols during major festivals and mass gatherings, specifically Deepavali, Ganesh Chaturthi, the Sabarimala Pilgrimage, and the Attukal Pongala.

#### Water and Air Quality Monitoring

- Undertaking routine monthly water quality screening across 347 baseline stations located in the state's water bodies, paired with comprehensive bi-annual testing for heavy metals and chemical pesticide runoff (Ongoing Project).
- Deployed an automated, real-time water quality monitoring station upstream of the Pathalam Bund in Ernakulam.
- Operating a statewide network of 40 manual testing stations to consistently map ambient air quality parameters (Ongoing Project).
- Installed 9 Continuous Ambient Air Quality Monitoring Systems (CAAQMS) distributed across key urban hotspots: Ernakulam (3), Thiruvananthapuram (2), Kollam (1), Thrissur (1), Kozhikode (1), and Kannur (1).
- Commissioned 2 Real-Time Noise Monitoring Stations (RTNMS) in Thiruvananthapuram and Ernakulam districts.
- Compiling and publishing the comprehensive State Water and Air Quality Directory annually for public review, accessible website via the link: (<https://kspcb.kerala.gov.in/water-and-air-quality-directory>)
- Water and air quality monitoring information is published on integrated web portal.
- A continuous monitoring system has been set up to measure wastewater/ air quality from industries.

#### Surveillance

- Surveillance of Sabarimala is routinely conducted by establishing camp offices at Sannidhanam, Pamba, and Erumeli during the pilgrimage season, as well as setting up laboratories to analyse the drinking water distributed at Sabarimala and Pamba.
- The board's Environment Surveillance Centre in Eloor monitors the Eloor-Edayar industrial area through a CCTV system equipped with night-vision cameras.
- The Board has developed an online vehicle tracking system to monitor the movement of all types of waste, including solid waste and biomedical waste, both within and outside the state borders. This will help prevent illegal waste transportation.

- Regular inspections are conducted at establishments under the Board's purview to ensure compliance with pollution control regulations.

#### Air Pollution

- Air pollution is a continuous and deep-rooted public health issue. The main sources are emissions from vehicles, atmospheric dust, dust related to construction and demolition activities, road dust, industries, domestic activities, waste burning, emissions from legacy waste dumpsites, and agricultural residues.
- Public awareness about air pollution and its adverse impacts is crucial in effectively tackling this issue.
- The National Ambient Air Quality Standards have been published as per the notification dated November 18, 2009.

#### Air Quality Index - AQI

- AQI is a system designed to communicate air quality to the public in an easily understandable way. It converts complex air quality data involving various pollutants into a single number (index value), a nomenclature (category name), and a colour code.
- The AQI is calculated using eight specific air pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, Pb)

#### Sources of Water Pollution

- Domestic waste
- Industrial waste
- Pesticides, detergents, and chemical fertilizers

Proper basic infrastructure is essential for water pollution control, specifically the establishment of Sewage and Septage Treatment Plants to handle domestic wastewater and Effluent Treatment Plants to treat industrial waste. Ensuring the regulated and controlled use of pesticides, along with managing soil erosion at construction sites, will also significantly help prevent water pollution. Ultimately, achieving effective water pollution control requires comprehensive water resource policies implemented at all levels, supported by continuous assessments and periodic reviews.

### **Waste Management**

#### Solid waste management

- Under the Solid Waste Management Rules, the Board grants formal authorization to local self-government institutions, which are strictly responsible for ensuring that adequate waste management facilities are in place.

- Local self-government institutions must submit annual reports to the State Board. The State Board then compiles these inputs into a comprehensive annual report and submits it to the Central Pollution Control Board.
- For treating organic waste at the source or in a decentralized manner, systems like aerobic composting, pipe composting, kitchen bins, and small-scale biogas plants can be utilized.
- A centralized Compressed Biogas (CBG) plants can be used for organic waste.
- Sanitary waste must be safely disposed of either through centralized biomedical waste treatment plants or by utilizing sanitary napkin incinerators.
- The Board has officially issued a Standard Operating Procedure (SOP) to regulate rendering plants that process poultry and animal residues.

#### Plastic Waste Management

- According to the 2023–24 annual report, approximately 71,000 tonnes of plastic waste are generated in the state every year.
- Currently, 35,352 Haritha Karma Sena members operate across 93 urban local bodies and 941 Grama Panchayats to collect plastic waste. The collected material is segregated and processed through recyclers. There are 123 registered plastic recycling units operating in Kerala.
- Non-recyclable plastic waste is collected at RRF and utilized either for co-incineration in cement plants or shredded to be used in road tarring.
- In accordance with the Central Pollution Control Board's order number CP-99/143/2021-UPC-11-HO-CPCBHO/8459 dated February 7, 2023, an official ban has been imposed on single-use plastics.

#### Hazardous Waste Management

- In accordance with the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and its amendments, the Kerala State Pollution Control Board grants formal authorization for the handling, collection, treatment, transport, storage, reuse, recycling, recovery, pre-processing, co-processing, and disposal of hazardous waste within the state.
- As mandated by law, every authorized unit must submit an annual report detailing their waste generation and management activities.
- Based on these individual unit submissions, the State Board compiles and submits a comprehensive annual report on hazardous waste management to the Central Pollution Control Board (CPCB).
- In accordance with the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and its subsequent amendments, the Kerala State Pollution Control Board grants formal authorization for the handling, collection, treatment,

transportation, storage, reuse, recycling, recovery, pre-processing, co-processing, and disposal of hazardous waste within the state.

- As mandated by law, every authorized unit must submit an annual report detailing their waste generation and management activities.
- Based on these reports, the Board submits an annual report on hazardous waste every year to the Central Pollution Control Board (CPCB).
- The list of EPR registered recyclers for E-waste, Battery waste, and Waste tyres is available on the Board's website.

### **3. Kerala Water Authority**

#### **Sewerage System**

Approximately 80% of the water we use daily for drinking, bathing, cooking, and other everyday needs returns to the earth as wastewater. It is absolutely essential that this wastewater generated from households and institutions is treated scientifically to prevent environmental damage. If left untreated, it will inevitably seep into groundwater resources and flow into streams, rivers, and other water bodies, resulting in severe water pollution and the widespread outbreak of waterborne diseases.

Wastewater generated from human activity can be broadly classified into two categories. Wastewater originating from toilets is referred to as sewage or blackwater, while wastewater from bathrooms, kitchens, and other domestic uses is known as greywater. Naturally, sewage is relatively more hazardous.

Septic tanks and Sewage Treatment Plants are the primary methods used to treat sewage. However, the common practice is often just digging pits and directing toilet waste into them. This type of setup does not actually treat the sewage. Untreated sewage seeps into the groundwater, and in situations where a safe distance cannot be maintained between a leach pit and a well, it mixes with well water. As population density rises and houses are built closer together, this creates severe public health and environmental issues. It is important to remember that when checking the safety of our well water, looking only at the distance to our own household pit is not enough; the distance from neighbours' pits must be factored in as well.

A septic tank is a localized method to manage sewage right at home. However, only a limited amount of purification takes place inside a septic tank. Solid matter and other particles in the sewage settle to the bottom of the tank, and certain organic wastes are broken down through anaerobic microbial action (processes driven by microorganisms). The liquid effluent exiting the septic tank can then be safely discharged into the ground through a soak pit. Over time, as the septic tank fills up, it must be cleaned out. Mechanical systems are widely available to pump out and clean this accumulated mix of solids and liquid wastewater, which is collectively known as septage.

To treat sewage completely and render it entirely safe, a dedicated Sewage Treatment Plant (STP) is required. These plants carry out Primary Treatment and Secondary Treatment, and if necessary, advanced Tertiary Treatment can also be implemented. Depending on the local geography and urban planning needs, these sewage treatment plants can be set up either as a single centralized facility to manage an entire region's waste or as smaller, decentralized plants serving localized clusters.

### **Sewage Treatment Plants in Kerala**

At present, a centralized wastewater disposal system is available only in Thiruvananthapuram, Kochi, and Guruvayur within the state of Kerala.

#### **The major processes associated with sewage treatment are as follows:**

- **Water Sampling and Testing**  
Water samples are collected regularly from water sources (such as rivers and reservoirs), treatment plants, and distribution networks (including households and public taps).

#### **Testing Parameters**

- **Physical:** Turbidity (cloudiness), colour, and odour.
- **Chemical:** pH, residual chlorine, heavy metals (such as iron and lead), nitrates, and fluoride.
- **Biological:** Total coliform, E. coli, and other microbial contaminants.
- **Laboratories:** Testing is conducted using laboratories authorized by the KWA (Kerala Water Authority), strictly adhering to BIS (Bureau of Indian Standards) guidelines or WHO (World Health Organization) standards.

#### **Treatment Process Monitoring:**

- **Coagulation & Filtration:** Removes suspended particles and pathogens (disease-causing microorganisms).
- **Disinfection:** Chlorination (the most common method) or advanced methods like UV (Ultraviolet) irradiation and ozonation in high-risk areas.
- **Residual Chlorine Monitoring:** Ensures adequate disinfection throughout the entire distribution system.

#### **Monitoring and Surveillance**

- **Routine Inspection:** Checking for pipeline leaks and contamination risks (e.g., cross-connections with wastewater/sewage lines).
- **Real-Time Sensors:** Deployed in critical zones to monitor vital parameters such as chlorine levels and turbidity.

- Collaboration: Partnering with the Kerala State Pollution Control Board and the Health Department during outbreaks of communicable diseases like cholera and jaundice.

### **Public Reporting and Complaint Redressal**

- Water Quality Reports: Shared with the public either through KWA offices or via online portals.
- Consumer Feedback: Complaints regarding odour, colour, or health issues/illnesses are investigated immediately.

### **Infrastructure Maintenance:**

- Pipeline Cleaning: Routine flushing is carried out to prevent bio-film build-up.
- Leak Repairs: Minimizes the risk of contamination entering the system from external sources.

### **Compliance & Certification**

- Strictly complies with IS 10500 (Indian Drinking Water Standards).
- Testing accuracy is ensured through certified laboratories and trained staff adhering to ISO/IEC 17025 protocols.
- Awareness & Training
- Staff Training: Provides personnel with the latest updates and advancements in water safety protocols.
- Public Campaigns: Educates the community on the vital importance of water conservation and pollution prevention.

### **Obstacles & Challenges**

- The system faces ongoing contamination challenges from agricultural runoff (containing pesticides), industrial effluents, and aging water infrastructure.
- KWA utilizes an established, systematic approach that emphasizes preventative measures alongside rapid-response protocols. This structured strategy ensures the continuous supply of safe, clean drinking water to everyone.

## **4. Kerala State Disaster Management Authority (KSDMA)**

Disasters are profoundly linked to environmental changes and ecological degradation. Due to diverse geographical features, different regions in Kerala face distinct types of disaster vulnerabilities. The ultimate consequence of any disaster is the tragic loss of human and animal life, alongside severe health, economic, and social setbacks. Because of this, specialized, proactive preparedness is essential to mitigate and face these events. Disasters frequently

disrupt ecosystems, creating environmental imbalances that trigger a sharp rise in communicable diseases and other health crises. In recent times, Kerala has witnessed a rise not only in national-level disasters but also in a growing number of state-specific catastrophic events.

## Warnings and Preparedness

The Kerala State Disaster Management Authority (KSDMA) and the State Emergency Operations Centre (SEOC) maintain a robust weather monitoring and early warning system in the state by continuously analysing data integrated from various official and private agencies. For comprehensive surveillance, the state utilizes the India Meteorological Department's (IMD) network—which includes approximately 21 Automated Weather Stations, 5 Automated Rain Gauges, 68 Manual Rain Gauges, and 2 Doppler Radars—alongside live weather monitoring data such as Skymet which has 94 weather stations. This collaborative network allows authorities to monitor daily parameters such as wind, rain, extreme heat, lightning, cyclones, water levels in rivers and dams, as well as coastal hazards like tsunamis and swell surges (Kallakkadal). Once analysed, this crucial information, along with specific safety alerts, is promptly communicated to the public and relevant government departments through social media and district disaster management authorities to ensure timely disaster preparedness and mitigation.

Climate change and natural disasters are deeply interconnected phenomena that are broadly classified into national and state-specific categories based on their scale and regional impact. National disasters encompass major catastrophic events such as floods, landslides or rockfalls, droughts, cyclones, cloudbursts, earthquakes, tsunamis, wildfires, hailstorms, pest attacks, cold waves, and avalanches. In addition to these widespread threats, certain localized hazards are designated as state-specific disasters due to a region's unique geographical vulnerabilities; these include coastal erosion, lightning, strong winds, soil piping, human-wildlife conflict, and extreme heatwaves or sunstrokes.

The Kerala State Disaster Management Authority (KSDMA) outlines comprehensive guidelines in its "Orange Book" detailing the environmental and technical preparations required by every government department at the state, district, and taluk levels during each phase of a disaster. To implement these measures effectively, departments can seek assistance from the District Disaster Management Authority (DDMA), while the Chief Secretary periodically convenes inter-departmental and district-level meetings to make critical decisions based on changing weather patterns. Ahead of the monsoon, KSDMA analyses various meteorological models to lead discussions and finalize action plans with all departments and District Collectors, while also actively utilizing social media to broadcast timely alerts to both the public and official sectors. When the India Meteorological Department (IMD) issues an orange alert for heavy rain or during other high-risk situations, KSDMA dispatches special warnings to districts to trigger localized preparations, which may be further escalated through State Executive Committee meetings where department heads implement high-level protocols,

including proactive guidelines to prevent and contain the infectious disease outbreaks that frequently follow climatic shifts and natural disasters.

The Central Water Commission conducts continuous monitoring of various rivers in Kerala and has developed the **KWIRS** system for this purpose. To further strengthen preparedness, the Kerala State Disaster Management Authority (KSDMA)—with the assistance of UNEP, UN-GRID, and the Nirma Foundation—has prepared comprehensive flood hazard maps modelling potential scenarios for 10, 25, 50, 100, and 200 years. These maps are highly effective for local planning, as they allow authorities and local self-government institutions to pinpoint specific flood-prone areas and estimate potential floodwater heights within their boundaries. To ensure public safety and awareness, all of these local data points, alongside a consolidated hazard map for the entire state of Kerala, have been officially published by the Disaster Management Authority on their website for open public access.

The Kerala State Disaster Management Authority (KSDMA) has issued clear operational guidelines for local self-government institutions and other departments to execute when the India Meteorological Department (IMD) releases severe wind warnings. Simultaneously, in the event of rising river water levels or when orange and red alerts are issued for consecutive days, the District Disaster Management Authority (DDMA) will actively take measures to evacuate and safely relocate residents living in highly vulnerable, hazardous, or risk-prone terrains to prevent casualties.

Based on the alerts issued by INCOIS (Indian National Centre for Ocean Information Services) regarding tsunamis, swell surges (Kallakkadal), dangerous waves, and ocean conditions during cyclones, the State Disaster Management Authority (SDMA) issues targeted safety directives, including specific advisories to suspend fishing operations when sea conditions become hazardous. Furthermore, the authority provides customized instructions detailing exactly which districts must step up their preparedness to tackle localized disasters such as flooding, landslides or mudslides, and severe coastal erosion.

Due to Kerala's diverse topography, a one-size-fits-all approach to disaster management is ineffective, as the mitigation plans required for mountainous regions differ significantly from those needed in coastal zones. Recognizing these distinct geographical vulnerabilities, guidelines have been issued to consolidate the specific disaster risks of each district, mandating the formulation of customized Local Disaster Management Plans tailored to address regional hazards effectively.

To effectively disseminate official disaster alerts to the general public, Kerala has installed sirens across 91 locations that can be directly operated from the State Disaster Management Authority (SDMA). Additionally, the National Disaster Management Authority (NDMA) has developed the 'SACHET' application for public alerts, enabling warning agencies to broadcast critical information through the CAP platform. These alerts are verified by the State Emergency Operations Centre (SEOC) before being targeted and delivered to the public based on their geographical location, with the SACHET app readily available for download on the Play Store.

Hospitals play a critical role in mitigating the impact of any catastrophe, especially since they house a high concentration of vulnerable people who are at immense risk if an emergency occurs internally or externally. Recognizing this, the Disaster Management Authority prioritizes both structural and technical hospital safety, mandating the formulation of comprehensive Hospital Disaster Management Plans to handle mass casualties, ensure operational readiness, and implement strict protocols to prevent the outbreak of infectious diseases within and around healthcare facilities during crises. Furthermore, the Kerala State Disaster Management Authority (KSDMA) requires the creation of Animal-Inclusive Disaster Plans that detail how to rescue, shelter, and safely relocate livestock and pets during emergencies. The Orange Book very precisely describes what to do immediately in the event of disasters involving each haz-met code, the immediate emergency protocols for hazardous materials incidents and detail the precise response mechanisms required to tackle complex Chemical, Biological, Radiological, and Nuclear (CBRN) disasters effectively.

Instructions have been issued directing respective departments to conduct specialized training for local healthcare workers, veterinarians, and community volunteers on post-disaster disease prevention, food safety, and vector control. Furthermore, the guidelines clearly outline the specific duties and operational protocols that each department must execute during such critical situations to ensure a well-coordinated response.

Guidelines have been issued to ensure community-wide preparedness and preventive measures against infectious diseases such as Nipah, leptospirosis (rat fever), and dengue, stopping them from escalating into large-scale disasters. This proactive capability was evident during the COVID-19 pandemic, when the Disaster Management Authority successfully initiated early case identification, deployed tracking mechanisms, and utilized epidemic modelling to predict disease severity and transmission trends. Furthermore, leveraging the Disaster Management Act of 2005, the authority played a pivotal role in controlling the pandemic by enforcing strict containment zones and movement restrictions across districts. Today, the Kerala State Disaster Management Authority (KSDMA) continues to maintain special surveillance over zoonotic diseases (infections transmitted from animals to humans) like Nipah and mpox, as well as any uncontrolled surges in common communicable diseases.

## **Camp Management**

Managing relief camps during disasters is a highly critical task, as survivors—including vulnerable groups, individuals with pre-existing medical conditions, and people of all age groups—are relocated to shared, often resource-limited environments. To prevent the outbreak of infectious diseases in these settings, maintaining personal hygiene and ensuring the absolute safety of food and drinking water are paramount. Addressing these specific challenges, the Kerala State Disaster Management Authority (KSDMA) has published a comprehensive document titled the '**Kerala State Minimum Standards of Relief**'. This document provides strict operational guidelines on setting up temporary shelters and implementing effective vector control measures to prevent pest-borne diseases. Furthermore, it explicitly details the baseline protocols required for food handling, safe water supply, healthcare monitoring, personal

sanitation, and waste management. Crucially, these standards focus on safeguarding vulnerable demographics such as women, children, pregnant individuals, the elderly, and patients, ensuring that their fundamental health, privacy, and safety needs are met even in the most challenging emergency conditions.

The District Administration and the Revenue Department are mandated to identify structurally sound and safe public buildings—such as schools, community halls, and government facilities—located entirely outside high-risk flood or landslide zones, ensuring these temporary shelters are registered and continuously updated on the **IDRN (India Disaster Resource Network)** portal. To guarantee the comprehensive safety and wellbeing of all displaced individuals, inter-departmental protocols designate specific operational responsibilities across multiple sectors. The Police, Revenue, Social Justice, and Women and Child Development departments work in tandem to secure the premises, prevent exploitation, and address the specific privacy and psychological needs of women, children, the elderly, and differently abled individuals. Concurrently, the Local Self-Government Department (LSGD), Kerala State Electricity Board (KSEB), and the Public Works Department (PWD) are responsible for ensuring essential civil infrastructure, including uninterrupted power supply, functional backup generators, running water, proper sanitation facilities, and basic structural safety. Given the heightened risk of disease transmission in crowded environments, continuous public health surveillance within the camps is highly critical. The Health Department is tasked with setting up active medical monitoring systems to prevent the outbreak of communicable and zoonotic diseases. This includes conducting targeted health screenings for chronic or infectious conditions like HIV, Tuberculosis (TB), and Malaria, alongside executing immediate vaccination campaigns for preventable diseases like Tetanus, Measles, and Hepatitis. Furthermore, vector control protocols—such as routine fogging, the application of larvicides, and environmental modifications to eliminate stagnant water—are strictly mandated to suppress mosquito breeding and interrupt the transmission pathways of vector-borne illnesses.

To protect livestock during disasters, the Disaster Management Authority has issued strict directives requiring the establishment of dedicated animal shelters positioned at a minimum safety distance of 100 meters away from human relief camps. Under these protocols, coordinated directly with the Animal Husbandry Department, authorities are mandated to distribute essential cattle feed and clean drinking water to prevent malnutrition, dehydration, and the rapid spread of diseases among displaced animals. By ensuring the prompt delivery of emergency veterinary services and robust disease-surveillance measures, the authority aims to mitigate livestock casualties and effectively control the outbreak of zoonotic and animal-specific infections during crises.

To prevent the outbreak of foodborne illnesses in relief camps, the Disaster Management Authority has established strict operational guidelines governing safe food handling, preparation, and storage. These protocols explicitly define the age-appropriate minimum daily caloric intake required for displaced individuals, while outlining the specific sanitary practices that must be maintained across all camp kitchens. The Health Department and the Integrated Child Development Services (ICDS) are jointly tasked with monitoring these nutritional and

hygiene standards, ensuring that infants, children, and vulnerable groups receive adequate dietary support. Furthermore, to foster sustainable and eco-friendly camp management, the guidelines advocate for reducing the environmental carbon footprint by prioritizing the sourcing of locally available, seasonal produce. This sustainable approach is reinforced by mandates to minimize food wastage, implement localized composting methods for organic waste management, and provide robust administrative support to community kitchens, ensuring long-term resource efficiency during extended relief operations.

Camp kitchens are required to strictly adhere to rigorous sanitation protocols, including systematic waste management and mandatory water purification practices. Ensuring access to safe drinking water is a top priority, with a minimum daily allocation of 2.5 to 3 litres per person. Before any water source is used, it must be thoroughly tested for *E. coli* and coliform bacteria, and if its quality cannot be guaranteed, proper chlorination and boiling are mandated. The Disaster Management Authority has issued clear guidelines defining these water quality standards and assigning specific monitoring responsibilities to the respective departments. Furthermore, during periods of extreme heat, the protocols prioritize specialized care for vulnerable groups—such as the elderly, pregnant individuals, and infants—by ensuring the immediate distribution of Oral Rehydration Salts (ORS) and significantly increasing the overall water supply. To mitigate heat risks, camp administrators are also directed to set up designated cooling areas and shaded structures within temporary shelters to protect residents from thermal stress.

Rigorous sanitation standards in relief camps are absolutely critical to preventing widespread disease outbreaks and ensuring a safe, dignified environment for displaced individuals. To control the population of rodents and insects that transmit dangerous illnesses like leptospirosis (rat fever) and dengue, the systematic disposal of solid waste is essential. In flood-prone regions characterized by high water tables, the guidelines mandate the use of bio-toilets and alternative sanitation technologies to prevent soil and water contamination, alongside robust drainage management protocols designed to eliminate stagnant water and disrupt vector breeding cycles. These emergency waste disposal strategies for camps, hospitals, and residential areas are clearly operationalized through the 'Minimum Standards of Relief' publication.

To execute these measures, the Disaster Management Authority has defined precise responsibilities for key stakeholders, outlining the collaborative roles of Kudumbashree, the Local Self-Government Department (LSGD), and Suchitwa Mission in managing solid waste, while establishing separate, stringent disposal guidelines for healthcare facilities. Post-flood recovery protocols place a high priority on waste management and drainage clearance to suppress vector breeding. Within the camps, the guidelines strictly promote the use of biodegradable materials and the enforcement of plastic-free zones, alongside the meticulous segregation and disposal of hazardous medical and chemical waste. Finally, to maintain public hygiene and prevent overcrowding, the standards mandate a minimum ratio of one toilet for every 20 people, with strictly segregated facilities for men, women, and transgender individuals to guarantee absolute privacy and safety for everyone.

To facilitate quick and easy access, toilets must be located within 50 meters of the shelters, while a minimum safety distance of 30 meters from all water sources must be maintained to prevent contamination. In areas where functional sewerage systems are unavailable, the guidelines recommend the installation of pit latrines or eco-toilets, alongside the placement of essential personal hygiene supplies near these facilities.

To safeguard personal hygiene and dignity under crowded shelter conditions, the standards explicitly mandate the distribution of dedicated kits containing sanitary napkins, disposable paper bags, soap, and personal cleaning items for women. Furthermore, the guidelines ensure the supply of diapers for infants and bedridden individuals, along with the continuous distribution of cleaning agents and disinfectants to maintain stringent sanitation levels throughout the premises.

This publication directly reflects climate-resilient adaptation strategies explicitly designed to ensure comprehensive preparedness against extreme weather anomalies, including catastrophic floods, severe heatwaves, and acute water scarcities. By codifying these measures into a standardized framework, the guidelines mandate that relief operations remain highly adaptive to escalating climate risks. This involves implementing flood-proof infrastructure and elevated sanitation systems to prevent contamination during heavy inundation, establishing dedicated cooling zones and shade structures equipped with oral rehydration solutions to mitigate thermal stress during heatwaves, and enforcing strict water conservation, quality testing, and alternative supply protocols to safeguard public health during periods of severe drought.

To mitigate flood risks, climate-resilient temporary shelters must be identified in advance within safe, elevated zones, ensuring they feature adequate ventilation and cooling structures to prevent heat-related illnesses among displaced individuals. These facilities actively promote energy-efficient practices, including solar lighting and sustainable cooking alternatives like liquefied petroleum gas (LPG) over traditional firewood. Furthermore, the Disaster Management Authority places special emphasis on ensuring that the extensive network of Multi-Purpose Cyclone Shelters established across Kerala strictly adheres to these codified standards for food safety, pure drinking water supply, and systematic waste disposal. Concurrently, a core operational priority is maintained to ensure that all cyclone shelters and relief camps are designed to be thoroughly child-friendly, providing a secure, protective, and supportive environment for minors during crises.

The guidelines explicitly outline crucial measures to prevent waterlogging within shelters, ensure efficient rainwater drainage, and manage wastewater safely to eliminate the risk of groundwater contamination. To maintain optimal hygiene, the framework mandates systematic waste collection and processing at designated locations, while actively promoting recycling initiatives to derive value from waste materials. By adopting this integrated approach, the framework ensures that emergency response operations are seamlessly coordinated across vital sectors, including animal husbandry, public health, and environmental departments, for a cohesive and efficient crisis management effort.

The guidelines mandate the deployment of mobile health units alongside the strategic stockpiling of essential human medicines, vaccines, and veterinary pharmaceuticals directly within flood-prone regions to ensure uninterrupted medical access. To prevent the outbreak and transmission of devastating waterborne illnesses such as cholera and hepatitis, the framework enforces immediate emergency WASH (Water, Sanitation, and Hygiene) programs across all relief camps. Furthermore, it directs the integration of real-time meteorological, environmental, and epidemiological data to generate advanced early warnings for threats like dengue, chikungunya, and Nipah. This data-driven approach allows authorities to work in close coordination with the Animal Husbandry Department to actively detect, track, and disrupt cross-species disease transmission pathways before they escalate into public health crises.

To minimize post-disaster public health risks, the guidelines strictly mandate vector control measures and systematic solid waste management to eliminate the breeding grounds of mosquitoes and other disease-carrying pests. Concurrently, to prevent the outbreak of zoonotic illnesses that can cross over from animals to humans, mass vaccination campaigns are deployed for livestock and displaced animals immediately following flood events.

## **5. Suchitwa Mission**

The Suchitwa Mission operates as the specialized Technical Support Group for the waste management sector under the Local Self-Government Department (LSGD) of the Government of Kerala. Its primary responsibility is to extend comprehensive technical and organizational support to Local Self-Government Institutions (LSGIs) across the state. Beyond this core consultative role, the mission is tasked with spearheading strategic communication campaigns, formulating action plans, and organizing creative workshops and capacity-building training programs. Furthermore, the agency actively drives sector-specific research, publishes authoritative papers, conducts action research, and maintains rigorous monitoring and evaluation frameworks to ensure the sustainable and scientific implementation of waste management initiatives.

In addition to these responsibilities, the Suchitwa Mission serves as the nodal agency in Kerala for the implementation of major national and state-level sanitation initiatives, including the Swachh Bharat Mission (Urban), the Swachh Bharat Mission (Gramin), and the Communication & Capacity Development Unit (CCDU).

### **Processing of non-biodegradable waste**

Non-biodegradable waste refers to the materials we use in our daily lives that do not decay or decompose into the soil, rendering them unusable in their current state once discarded. Although these items become waste when they are no longer of any use to us, they still hold latent value; despite being discarded, it is entirely possible to make them useful once again, either by reusing them in their original form or by altering their structure through recycling processes.

- Classification of Non-Biodegradable Waste

This extensive category of non-biodegradable waste encompasses discarded packaging materials, plastic carry bags, bottles, broken furniture, damaged utensils, toys, brushes, tongue cleaners, and empty tubes of toothpaste, milk, and oil. It also includes aerosol spray cans, shampoo bottles, medicine blister strips, multilayered or low-density plastic wraps, thermocol, tin cans, broken buckets, cosmetic containers, disinfectant bottles, liquor and beer bottles, and general glassware. Additionally, it covers paper-based and recyclable materials like cardboard, newspapers, and magazines, alongside specialized waste such as fluorescent tubes, light bulbs, defective electronic or electrical appliances, batteries, footwear, bags, leather items, belts, vehicle tires, and various other rubber products.

The consequences of open burning and indiscriminate littering are catastrophic, especially since 80% of daily generated waste consists of low-density, non-recyclable materials with zero market value. When these materials are burned, they release highly toxic smoke that causes cancer and severe respiratory diseases in both humans and animals. Alternatively, when thrown away carelessly, this waste severely pollutes soil and water bodies, rendering agricultural land entirely infertile over time. As plastic accumulates beneath the ground, it forms an impermeable barrier that blocks rainwater from seeping into the earth, directly triggering artificial flash floods during downpours and severe water scarcities during dry spells. Furthermore, these makeshift dumpsites become breeding grounds for disease-carrying vectors, pests, and deadly viral strains, accelerating the spread of epidemics while choking rivers, streams, and oceans, ultimately destroying marine ecosystems and posing an existential threat to all life on Earth.

### **Solutions:**

- Reducing/avoiding the use of non-recyclable materials and segregation.
- Segregation of biodegradable and non-biodegradable waste.
- Cleaning, sorting, and storing materials with potential for recycling or reuse from among the non-biodegradable waste after use.
- Handing them over to the Haritha Karma Sena by paying the user fee.
- Collection and storage (at the Local Self-Government Institution level)
- Reuse, recycling, and scientific processing.

### **How to Segregate?**

#### **Step 1: Primary Segregation 1 – At Households and Institutions**

At households and institutions, non-biodegradable waste materials must be cleaned and kept separately without mixing them with biodegradable waste (the Haritha Karma Sena must conduct awareness campaigns for this purpose).

#### **Step 2: Primary Segregation of Non-Biodegradable Waste – At Households and Institutions**

At households and institutions, non-biodegradable waste materials must be categorized and stored separately as plastic, paper, metals, glass, e-waste, and leather items (the Haritha Karma Sena must conduct awareness campaigns for this purpose).

#### Step 3: Collection – From homes and institutions

The Haritha Karma Sena will visit households and institutions to collect non-biodegradable waste as per the calendar provided by the Clean Kerala Company.

#### Step 4: Temporary storage in Mini Material Collection Facility (MCF)

Storage of collected items at the Mini MCF (Material Collection Facility) and transporting them to the main Material Collection Facility (MCF) once full.

##### **Mini MCF**

The cabins established at the ward level to temporarily store the waste materials collected by the Haritha Karma Sena can be called Mini MCF.

#### Step 5: Secondary Segregation at the MCF (Material Collection Facility) –

##### **Material Collection Facility (MCF)**

MCF s are centres where waste materials collected from Mini MCF s are subjected to second- stage, value -added segregation. MCF s are sheds ranging from 500 to 1500 square feet in size.

#### Step 6: Tertiary Value-Added Segregation

Since plastic items account for nearly 80% of all recovered dry waste, executing a detailed secondary sort is vital because a plastic's ultimate market value fluctuates dramatically based on its physical size, thickness, and material grade. By meticulous sorting that directly matches the exact resin type, colour uniformity, and processing requirements of commercial recycling plants, local collection facilities can significantly boost their financial returns while providing premium, production-ready raw materials back into the circular economy.

Following value-added segregation, a specific category of materials will remain that cannot be classified under any of the standard recycling streams due to being completely non-recyclable. This includes low-density items like thin carry bags, plastic wrappers, multi-layer or Tetra Paks, medicine blister strips, and thermocol, as well as composite consumer goods manufactured by bonding multiple raw materials together, such as old footwear and bags. Because these items cannot undergo traditional recycling, they hold a negative market value in the commercial

waste sector, making it essential to actively explore alternative avenues for their creative reuse and safe, non-hazardous repurposing.

#### Step 7: Processing Low-Thickness Plastics for Road Tarring

Low-thickness plastic items (such as thin carry bags, wrappers, multi-layer or Tetra Paks, and medicine blister strips) can be separately sorted, packed into gunny bags, shredded, and transferred to a Resource Recovery Facility (RRF) to be utilized in road tarring, thereby transforming them into value-added products.

Step 8: The final remnants will consist of rejected items such as footwear, bags, and other valueless materials. From this remaining residue, any items that are found to still hold value can be segregated once again.

Example 1: For certain types of footwear, the upper part may be leather, while the sole might be made of recyclable plastic.

Example 2: Certain types of bags often use metal clips and other metal ornaments for decorative purposes. These can be dismantled and separated to be managed according to their market value. The remaining residues can then be sent to cement factories or scientific landfill sites for processing.

#### Step 9: Transfer to the RRF

### **Resource Recovery Facility**

An RRF (Resource Recovery Facility) is a building equipped with machinery designed to store waste materials categorized after second-stage segregation in MCFs, subject recyclable items to baling, and shred non-recyclable plastic materials.

Recyclable materials that have been segregated according to their market value can be packed into separate bags and moved from the MCF to the RRF.

Non-recyclable plastics that need to be shredded can be packed into separate bags and moved to the RRF.

All items that are completely non-recyclable or non-reusable (rejects) can be baled and transferred to the RRF to be sent to cement factories or landfill sites for scientific processing.

#### Step 10: Operations at the RRF

Two primary operations are carried out at the RRFs:

1. Shredding
2. Bailing

- Non-recyclable plastic materials must be shredded and transferred to the Local Self-Government Department, Public Works Department, and National Highways Technical Division at the rates fixed per kilogram by the Clean Kerala Company.
- Value-added waste materials that need to be sent to recycling plants for processing must be segregated by item type and baled separately.
- Bailing is essential to prevent different types of items from mixing during transportation and to enable the transport of a larger volume of waste materials at the same time.

#### Step 11: Transportation of Negative-Value Products (Rejects)

Footwear, bags, medicine strips (blister packs), thermocol (expanded polystyrene), and other rejected items are negative-value waste materials.

Such materials that cannot be recycled or reused can be transferred by entering into agreements with companies/agencies involved in utilizing them as fuel in cement factories or for sanitary landfilling.

(No income is derived from this. In certain circumstances, money may even have to be paid out to these entities.)

The recyclable materials exported from RRFs arrive at specialized recycling plants, though it is not necessary that all dispatched materials are recycled within the very same facility. Instead, recycling is carried out across various types of plants operating with distinct technologies based on the category of raw materials from which the waste items were manufactured, subsequently transforming them into new finished products or raw materials for manufacturing. Specifically, materials like plastics, metals, and e-waste are recycled using distinct, dedicated technologies, where the processes are uniquely tailored based on the melting point of each specific material. Following the recycling process, these items are converted either into ready-to-use new products or into raw materials designated for manufacturing new goods.

### **Liquid Waste Management**

Liquid waste is one of the major factors contributing to the pollution of our water bodies. It is also the primary reason for the increase in waterborne diseases. Wastewater/sewage from industrial and commercial establishments, houses near water bodies, and institutions reaches water sources through commode waste, drainages, and open channels, thereby polluting them. Simultaneously, water resources are being destroyed.

People who use these water bodies contract waterborne diseases and epidemics. As water purification plants and bottled water manufacturing companies depend on these sources for water, this has turned into a highly complex issue. The primary sources of liquid waste are as follows:

- Water mixed with human excreta from toilet commodes.
- Water generated as part of bathing and washing clothes.

- Water from washbasins in kitchens and rooms.
- Water from drainages.
- Wastewater discharged from commercial and industrial establishments.
- Wastewater from hospitals, markets, slaughterhouses, flats, and other institutions.

### **Management Methods**

- Liquid waste can be managed by setting up Sewage-Septage Treatment Plants, which is a technology designed to scientifically treat sewage-septage waste containing human excreta and convert it into manure and purified water. Septage waste and sewage waste can be managed either by setting up separate plants or together through co-treatment technological methods.
- By installing toilet-linked biogas plants in houses and institutions, excreta can be converted into biogas fuel.
- Water pollution can be prevented by constructing septic tanks as an alternative to single-pit toilets.
- Effluent Treatment Plants (ETPs) can be set up to manage wastewater from markets, slaughterhouses, and industrial establishments.
- Wastewater from households can be scientifically purified within the household premises itself by constructing soak pits.
- Wastewater generated in institutions (such as hospitals, hostels, schools, colleges, industries, malls, government offices, etc.) can be purified by installing decentralized sewage treatment plants (wastewater treatment plants) within those respective premises.
- Water purified through this system (provided the quality standards are strictly within the limits prescribed for various components) can be used for building construction, gardening, water closet flushing, vehicle washing, etc. If advanced technical methods are utilized to purify the water precisely, it can also be used for further purposes.

The Suchitwa Mission has been providing technical and financial assistance to Local Self Government Institutions (LSGIs) for setting up Septage Treatment Plants for safe human excreta disposal, Biogas plants, Sewage Treatment Plants for wastewater management, and Effluent Treatment Plants.

The Suchitwa Mission has empanelled various agencies (consultants) to understand the quantity and type of liquid waste generated daily, to prepare a Detailed Project Report (DPR) for establishing liquid waste treatment plants for Local Self Government Institutions, and to provide supervision for the implementation of the project.

*(For details, visit the website: [www.sanitation.kerala.gov.in](http://www.sanitation.kerala.gov.in)).*

- The Local Self Government Institution can select an appropriate agency from the said empanelled agencies through a tender process to prepare the DPR.
- The prepared DPR must be approved by the governing body, and after obtaining DPC (District Planning Committee) approval for the project, it should be submitted to the Suchitwa Mission along with supporting documents for technical sanction and financial assistance.
- After a detailed verification of the DPR, the Local Self Government Institution will receive technical sanction and eligible financial assistance from the Suchitwa Mission, subject to terms, conditions, and regulations.
- For the execution of projects that have received technical sanction, Local Self Government Institutions can find an implementing agency/contractor through an open tender process and complete the project.
- The plant can be maintained by conducting Operations & Maintenance through the agency/contractor installing the plant.
- The financial utilization certificate of the financial assistance received from the Suchitwa Mission must be submitted to the Suchitwa Mission in a timely manner.
- The Suchitwa Mission share allows up to 100% of the total project cost for plants established at the institutional level, and up to 75% for plants established at the community level.
- A minimum of 50 cents of land is required for community-level plants. For institutional-level plants, construction can be carried out considering the availability of land and the geographical features of the respective institutions.

### **Hazardous Waste / E-Waste Management**

Hazardous wastes are substances that fall under the third category and have recycling value. E-wastes are unusable electrical and electronic items generated in homes, institutions, etc.

Bottles and tins of pesticides and chemicals, batteries, bulbs, tubes, paint bottles, and tins of toxic substances fall under the hazardous waste category.

The wastes mentioned above must be safely collected and processed through government-authorized agencies. Wastes from households and institutions can be safely collected through the Haritha Karma Sena as per the calendar of the Clean Kerala Company and handed over for safe recycling either through the Clean Kerala Company or through agencies authorized by the Pollution Control Board/Government.

### **Clean Kerala Company**

Clean Kerala Company is a government institution under the Local Self-Government Department, entrusted with sorting and collecting unusable waste materials from Local Self-Government Institutions and government-public sector institutions to subject them to recycling.

- Sort waste materials separately as furniture, electronic/electrical items, paper, plastic, rubber, and metals.
- Households and private institutions must sort all types of waste materials and provide them through the members of the Haritha Karma Sena.
- Ensure that every item in government institutions is unusable, and if necessary, get it certified by experts.
- Prepare a separate list for each category and provide it to the Clean Kerala Company along with a request letter.
- The Clean Kerala Company will transfer the amount corresponding to the quantity of waste removed from each institution to the account of the respective institution as per the government order.

### **Toilet Schemes**

Technical and financial assistance is being provided to Local Self-Government Institutions to set up public toilets in public places, public institutions including educational institutions, and tourist centres. For the above schemes, 100% of the amount is sanctioned from the Suchitwa Mission, subject to the estimate of the Local Self-Government Institutions.

Financial and technical assistance is being provided from the Suchitwa Mission to Local Self-Government Institutions for projects to convert school toilets destroyed in disasters, toilets in waterlogged areas and coastal areas, and leach pit toilets into septic tanks/bio-digesters.

### **'Take a Break' Scheme**

For the safe use of women and children, toilet complexes with refreshment facilities are being implemented along national and state highways under the name 'Take a Break', included in the 12-point program of the Chief Minister of Kerala. Local Self-Government Institutions can prepare and implement projects for this. 50% of the total estimate amount of the project (up to a maximum of 5–7 lakh rupees) will be available from the Suchitwa Mission.

If the estimate, technical sanction, connected documents, and location sketch of the toilet projects requiring financial assistance from the Suchitwa Mission are certified by the technical wing officers of the Local Self-Government Institutions and submitted to the Suchitwa Mission, further steps will be taken to verify them and disburse the Suchitwa Mission's share.

### **Slaughterhouse / Poultry Waste Management**

Although they fall under organic waste, slaughterhouse waste and poultry waste are substances that require special handling. Wastes generated in meat-selling shops and chicken-selling shops can be called slaughterhouse waste. These are wastes generated after slaughtering birds and animals in this manner and separating the meat.

Around 15,680 meat shops and chicken meat selling centres operate in the State. From these, approximately 38,100 tons of slaughterhouse waste is generated annually in the state. The majority of this is processed unscientifically. Dumping such wastes in public places and water bodies leads to serious health and environmental problems.

Suchitwa Mission provides technical assistance to Local Self-Government Institutions for setting up modern slaughterhouses, rendering plants (slaughterhouse waste processing plants) suitable for processing slaughterhouse waste and poultry waste, to carry out slaughtering scientifically and to process slaughterhouse waste.

### **Processing Method**

By using technical methods such as modern slaughterhouses, slaughterhouse waste processing plants (rendering plants), compost pits, and biogas plants (those that come along with waste management), such wastes can be scientifically processed and converted into manure and value-added products. In addition, modern slaughterhouses equipped with such systems can be established.

- Suchitwa Mission has empanelled agencies (consultancies) to prepare Detailed Project Reports (DPR) for setting up modern slaughterhouses and rendering plants to assist Local Self-Government Institutions (LSGIs), as well as to provide support for work supervision.
- One of the agencies can be selected through a competitive tender to prepare the DPR. Subsequently, after obtaining technical sanction from the Suchitwa Mission, a

construction agency can be identified through a competitive tender to execute the project.

- Local bodies can grant permission to private entrepreneurs to construct and operate plants in this sector. Before granting a trade license (D&O License), Local Self-Government Institutions must ensure that slaughterhouse waste is being handled scientifically.
- Space Requirement – A minimum of 50 cents to one acre of land will be required.

### **Construction of Modern Gas Crematorium (Modern Gas Crematorium)**

A modern gas crematorium operates with modern and scientific systems utilizing LPG/Natural Gas as fuel. Suchitwa Mission provides technical assistance and guidelines to Local Self-Government Institutions for constructing modern gas crematoriums to dispose of human bodies. An animal crematorium scheme for disposing of animal carcasses is also in place. Suchitwa Mission has been empanelling agencies for installing modern crematorium furnaces, chimneys, etc.

### **Construction & Demolition Waste Management Plant (Urban) (Building Construction/Demolition Waste Management)**

Construction & Demolition Waste is waste generated as part of activities involving the demolition and construction of buildings. This project is designed for Local Bodies in urban areas. Currently, such wastes are being dumped on roadsides and public places. Since this is highly hazardous, the method to process them scientifically is to establish C&D plants and subject them to reuse. The components in the plant include an impact crusher, belt conveyor, weighbridge, sprinkler, etc.

- Urban Local Self-Government Institutions can find specific land for storing such wastes and plan projects for processing them.
- Financial assistance will be sanctioned from the Suchitwa Mission based on proposals submitted by Urban Local Self-Government Institutions.
- An amount of 20% of the total estimate cost, or up to a maximum of 40 lakh rupees, will be sanctioned from the Suchitwa Mission (subject to fund availability).
- For this, Local Self-Government Institutions shall prepare a proposal and submit it to the Suchitwa Mission, which will then technically verify it and take further necessary steps.

### **Other Activities**

#### **Mechanized Sweeping Machines (Urban)**

The mechanized sweeping machine project is designed for Local Self-Government Institutions in urban areas (Municipalities/Corporations) to quickly clean roads constructed to high standards. The sweeping machine is designed in a vehicle-mounted manner.

Municipalities/Corporations can purchase a mechanized sweeping machine with the required capacity through an open tender.

The Municipality/Corporation can select an agency through tender procedures. If the selected agency submits the specifications to the Municipality/Corporation, it can be forwarded to the Suchitwa Mission for verification and subsequent approval.

### **Conventional Waste Removal**

This is a project to scientifically clear accumulated legacy waste dumps in urban Local Self-Government Institutions using technical methods like biomining/bioremediation, sort the waste, clean those sites, and reclaim the land for other activities.

Since waste must be sorted and removed, this work can be implemented as a separate project. Suchitwa Mission will provide technical support for preparing specifications and tender documents to execute this work.

After the quantity of waste to be removed is scientifically assessed by the Local Self-Government Institutions, a detailed verification of the prepared and submitted estimate proposal will be conducted, following which eligible financial assistance will be granted to the Municipalities from the Suchitwa Mission. Subsequently, biomining/bioremediation must be carried out in compliance with the guidelines issued by the Central Pollution Control Board. If required, an execution agency can be found through a competitive tender (pre-qualification tender if necessary) to complete the work.

### **Pre-Monsoon Cleanliness Campaign**

The objective of the campaign is to clean public spaces, institutions, and water bodies to keep free from waste, thereby eliminating conditions for mosquito breeding and reducing vermin nuisance, as part of epidemic prevention ahead of the monsoon season. This activity is carried out every year in a campaign model with public participation. The campaign activities are conducted under the supervision of the Local Self-Government Department, Health Department, Local Self-Government Institutions, and other departments. Suchitwa Mission funds are allocated to Local Self-Government Institutions for these cleanliness activities.

## **6. State Wetland Authority Kerala (SWAK)**

For the protection of wetlands, under the Environment Protection Act, 1986, and as per the Wetlands (Conservation and Management) Rules, 2017 Section 5(1), the State Wetland Authority Kerala (SWAK) came into existence through the government order G.O. (Ms.) No.14/2017/Env. dt. 28122017, similar to all other states and union territories in India. This rule applies to wetlands of international importance under the Ramsar Convention, as well as all wetlands notified or to be notified by the Central/State Governments and Union Territories.

The Honorable Environment Minister is appointed as the Chairperson, the Chief Secretary as the Vice-Chairperson, and the Director of Environment and Climate Change as the Member Secretary. The Secretaries of various departments and subject experts from five fields - Wetland Ecology, Wetland Hydrology, Wetland Fisheries, Landscape Planning, and Socio-economics - are members of the Authority. Additionally, a Technical Committee and a Grievance Committee function under the Authority.

### **Responsibilities and Monitoring of the State Wetland Authority**

- Identify and list all wetlands to be identified in the State as per the Wetlands (Conservation and Management) Rules, 2017; recommend the identified wetlands based on brief documents for their regulation and notification from the digital inventory; develop a comprehensive list of activities to be regulated and permitted within the notified wetlands; and define strategies for their conservation and wise use.

## **Interventions**

### **1. Directorate of Environment and Climate Change**

#### **1.1 Kerala State Climate Change Action Plan (2023-30):**

Significant changes in climate have been observed globally in recent decades. Anthropogenic climate change is already causing numerous extreme weather phenomena across all regions of the world, including sea-level rise, heatwaves, cold waves, floods, droughts, and severe cyclones. Between 1901 and 2018, the global average sea level rose by 0.20 meters. While the average rate of sea-level rise was 1.3 millimetres/year between 1901 and 1971, it increased to 3.7 millimetres/year between 2006 and 2018.

Kerala is a region experiencing the impacts of climate change most prominently. Considering Kerala's unique geo-climatic-demographic characteristics, a long-term action plan based on scientific studies is indispensable to face the growing challenges due to climate change. It is against this backdrop that the State Directorate of Environment and Climate Change prepared the revised State Climate Change Action Plan for the period 2023-30.

Regarding the state's climate change history and projected climate assessment (Climate Change Base Case and Projections), a significant increase in temperature (moderate warming) has been recorded in the state from 1990 to 2020 during both the summer maximum temperature and the winter minimum temperature. Additionally, a decrease in the availability of average annual rainfall has been recorded in all other districts except Idukki, Palakkad, Kozhikode, and Wayanad.

According to the climate assessment projected for the 2021-50 period (Climate Change Projection) under Representative Concentration Pathways (RCP 4.5, 8.5) scenarios, it is projected that the temperature in the state will rise by 1 to 2 degrees Celsius. Furthermore, during the pre-monsoon, monsoon, and winter periods, the AYP especially OU and extreme rainfall is projected to increase under both these scenarios (RCP 4.5 & 8.5). During the post-monsoon period, the amount of rainfall is expected to decrease in the southern districts and increase in the northern districts. It is assessed that these changes will seriously affect sectors such as agriculture, animal husbandry, fisheries, forestry and biodiversity, water resources, tourism, and health, thereby disrupting the rhythm of the state's socio-economic systems.

#### **1.1.1 Climate Change Vulnerability Assessment**

Although climate change is a global phenomenon, its impacts and mitigation strategies are local. Therefore, assessing the risk vulnerability of each region in advance is the first step in climate change preparedness activities. As part of this, a district-level Composite Climate Change Vulnerability Analysis was completed to assess the state's preparedness for climate

change. Alappuzha, Idukki, Wayanad, Palakkad, Kozhikode, Kasaragod, Kannur, and Malappuram districts were identified as highly vulnerable districts.

Factors such as high prevalence of infectious diseases, a relatively higher population of children, the elderly, and differently abled individuals, a lack of availability of healthcare systems and relief centres, inadequacy of irrigation facilities, and a decline in the quality of groundwater and surface water contribute to reducing the climate change adaptation capacity in these districts. This vulnerability data helps develop a precise understanding and design adaptation-focused interventions for the hotspot districts where priority should be given in climate change adaptation activities.

However, this does not mean that other districts are fully prepared to face the challenges posed by climate change. Based on the indicators representing vulnerability, they are merely relatively better off compared to the highly vulnerable districts. In addition to the integrated assessment, separate vulnerability assessments were conducted across seven sectors: agriculture, animal husbandry, fisheries, forestry and biodiversity, water resources, tourism, and health. It is on the basis of these assessments that adaptation activities have been formulated in the revised Climate Change Action Plan.

### **1.1.2 Climate Change Mitigation Activities**

Climate change mitigation activities involve reducing the emission of greenhouse gases or increasing the process of carbon sequestration through various methods. Kerala is a state in India with relatively low greenhouse gas emissions. The primary reasons for these low emissions are the state's extensive forest cover, and activities focused on energy conservation and improving energy efficiency. Around 80% of the state's greenhouse gas emissions come from energy sectors such as electricity generation, transport, industries, agriculture (energy consumption), and buildings.

#### **Proposed Mitigation Strategies and Activities (202330)**

Based on the projected electricity demand by the Central Electricity Authority, it is expected that Kerala's electricity demand will increase by 50% by 2030 compared to the year 2015. As the demand [for energy] increases, this Action Plan envisions rational emission reduction targets. Compared to the current scenario, the planned mitigation strategies envisioned under the Action Plan can avoid 57,000 KtCO<sub>2</sub> of carbon emissions from various sectors by 2030. An investment of approximately 52,238 crores is required for this purpose. Out of this, the state's share is estimated to be around 5%, and the central government's share is estimated at 23%. The remaining portion is calculated as the private/consumer share. The major planned mitigation measures are detailed below:

- Establishing electricity projects based on renewable energy sources.
- Improving energy efficiency in the industrial sector.
- Improving electricity transmission and distribution systems.
- Increasing the adoption of Electric Vehicles (EVs).

The proposed mitigation measures for 2030 include the following: increasing renewable energy sources to 3.46 gigawatts; reducing transmission and distribution losses to 8.8 percent; installing 53% energy-efficient lighting points in the domestic sector; increasing the share of electric vehicles in public transport; equipping the agricultural sector with solar-powered and energy-efficient systems; and improving the energy efficiency of other industries as well as micro, small, and medium enterprises through PAT (Perform, Achieve and Trade).

### **1.1.3 Climate Change Adaptation Activities**

Climate change adaptation refers to shaping a lifestyle that adapts to changing climatic conditions and reduces the vulnerability/risks arising from the impacts of climate change. Adaptation planning has been carried out for the sectors identified in the vulnerability assessment. The causes of vulnerability and the impacts within each sector have been identified, and based on that, adaptation activities have been formulated.

#### **Proposed Adaptation Strategies and Activities:**

**(i) Agriculture:** The adaptation activities in this sector aim at climate-resilient farming practices and economic profitability in the most vulnerable districts. This includes climate-resilient agricultural production activities, reducing post-harvest losses, and enhancing the capacity of supporting institutions and service providers in this field.

**(ii) Animal Husbandry:** This includes activities and projects to ensure nutrition, healthcare, and climate-resilient cattle sheds, cages, and breeding facilities necessary to increase the productivity of livestock. Through this, it aims at climate-resilient cattle rearing, high farm income, and high farm returns by integrating milk production and backyard poultry farming, converting poultry farm waste into value-added products, and reducing mortality rates through disease control and preventive measures.

**(iii) Fisheries:** The objective of the projects and activities envisioned in this sector is to ensure food security and sustainable high income by increasing coastal and inland aquaculture production. The adaptation activities in this sector include establishing facilities including secure housing for those whose livelihoods depend on fisheries and agriculture in climate-resilient coastal villages, diversifying livelihood-income sources, reducing losses caused by coastal disasters, and developing infrastructure for post-harvest resource management.

**(iv) Forestry and Biodiversity:** Some districts in the state are seen to have forest areas and vegetation cover with relatively low biodiversity, along with low water resources. This sector absolutely requires and includes adaptation strategies aimed at increasing biodiversity within notified forests and other forested areas, controlling invasive species, preventing forest fires, and managing human-wildlife conflict to enhance adaptation capacity.

**(v) Health:** Palakkad, Malappuram, and Kasaragod districts have been identified as the relatively most vulnerable districts in this sector. To reduce the vulnerability of these districts, adaptation strategies have been envisioned to improve healthcare infrastructure, availability of services, drinking water supply, insurance coverage, and emergency medical services for vulnerable sections of the population. To achieve these goals, priority activities have been included, such as integrating climate data into disease surveillance warning systems,

strengthening emergency healthcare systems in areas highly prone to mortality due to extreme climate events, and improving the management of liquid and solid waste, including biomedical waste.

**(vi) Water Resources:** Wayanad, Alappuzha, Kottayam, and Kozhikode are the districts with relatively higher vulnerability in this sector due to reasons such as low density of drainage channels, inadequate irrigation facilities, poor surface water quality, very low groundwater levels, and a lack of climate observation stations. High population density in certain areas and the non-availability of purified drinking water throughout the year are also seen as causes that increase the pressure on water resources. The interventions formulated and included through discussions for this sector include ensuring safe drinking water availability, setting up sustainable drainage systems, and establishing a water resources information system.

#### **1.1.4 Priority Interventions**

In addition to sector-level interventions, strategies for climate change adaptation have been identified and projects have been planned in areas requiring priority by analysing the state's Climate Profile, Composite Climate Change Vulnerability Analysis, and Stakeholder Recommendations from relevant departments. Climate change adaptation projects are necessary to resist the climate change risks of the state and are capable of mitigating cross-sectoral impacts. The interventions are mentioned below:

1. Land Use Planning and Zoning
2. Sustainable Protection and Stabilization of Shores and Riverbanks
3. Rehabilitation & Resettlement of Vulnerable Communities
4. Plan and Maintain Sustainable Drainage Systems to Reduce Flood Impact
5. Integrated and Planned Coastal Zone Management
6. Climate Change Monitoring and Database Management
7. Climate Responsive Local Governance
8. Climate Change Education and Awareness

For this purpose, focusing on the Sustainable Development Goals and Nationally Determined Contributions fixed at the national level, various projects worth 12,420 crores have been envisioned in SAPCC 2.0 from the financial year 2023-24 to 2030-31.

#### **1.1.5 Financial**

For the proposed climate change mitigation projects for the state, a total amount of 1,52,238 crores is estimated, and for adaptation projects, 38,407 crores are estimated. The joint action of Central and State Governments is indispensable to provide financial assistance for the planned activities envisioned in the action plan. To meet the expenditure of mitigation and adaptation activities in the action plan, the Central Government needs to make additional resources available to the State.

Details are provided for providing financial assistance to the State Action Plan, which has been prepared to face the adverse effects of climate change in accordance with the guidelines of the Central Ministry of Environment, Forest and Climate Change.

#### **1.1.6 Institutional Mechanism**

The State Climate Change Governing Council (Chief Minister's Governing Council on Climate Change), chaired by the Chief Minister, will function as the apex governance institutional mechanism. The Governing Council, which functions with the support of the State Level Steering Committee, consists of the Chief Minister, Ministers in charge of departments such as Environment-Climate Change, Agriculture, Animal Husbandry, Fisheries, Forestry, Health, Irrigation, Energy, Transport, Finance, Disaster Management, and Local Self-Government, along with Ministers nominated by the Chief Minister, the Vice Chairperson of the State Planning Board, the Chief Secretary, and the Environment Secretary as members.

The State Level Steering Committee will continue to function as the high-level executive committee with the support of the State Climate Change Cell, and the working groups and advisory committees for climate change mitigation, adaptation, and research-partnership-training. The aforementioned advisory committee will include State Planning Board members and academic/research experts at national and international levels.

The State Climate Change Cell established under the Directorate of Environment and Climate Change will be the nodal institution for coordinating activities in the state. District Climate Change Cells will lead at the district level, and working groups formed at the Local Self-Government institution level for environment, biodiversity, climate change, and disaster management will lead climate change adaptation and mitigation activities at the local level.

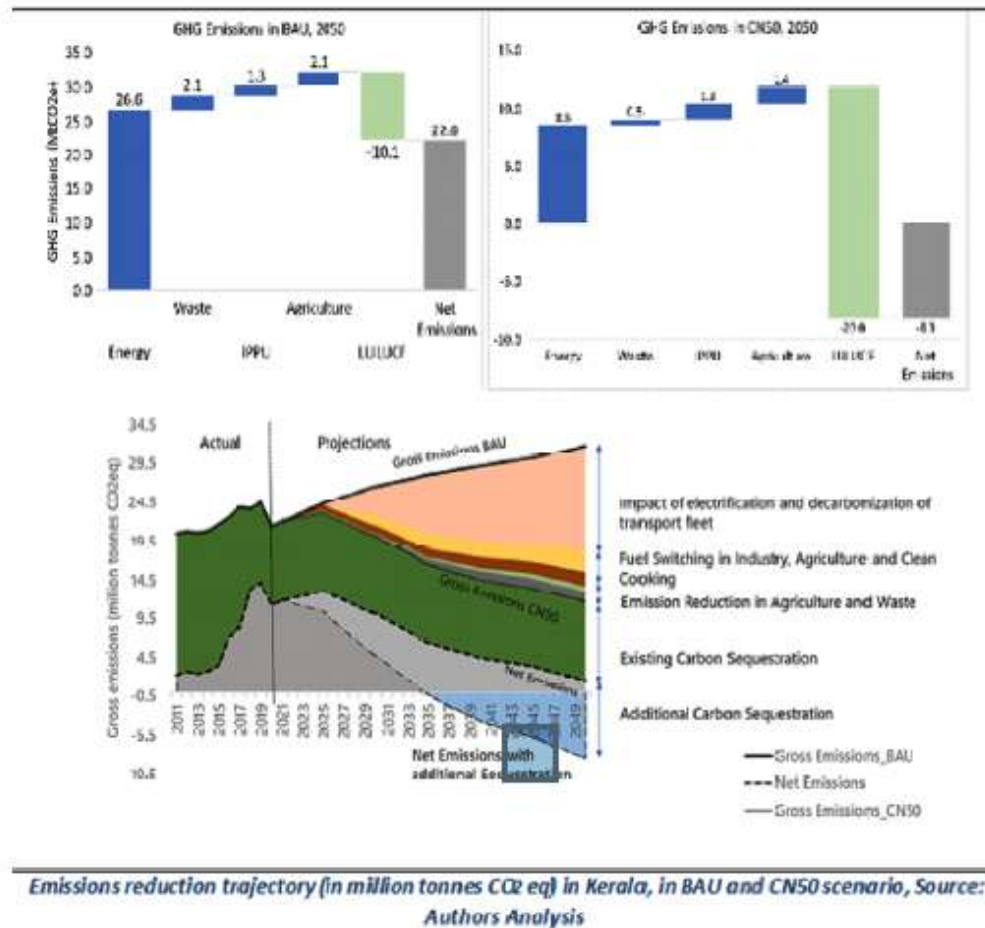
#### **1.1.7 Action Plan Monitoring and Evaluation**

Specific monitoring and evaluation mechanisms have been envisioned for various adaptation and mitigation activities proposed in the action plan based on indicators.

### **1.3 Carbon Neutral Kerala by 2050 – Action Plan**

Based on the greenhouse gas emission assessment report of the state, a draft action plan to achieve the goal of Carbon Neutrality by 2050 has been prepared by the Directorate of Environment and Climate Change in collaboration with the Vasudha Foundation. In this, the action plan aims to reduce emissions from major emission sectors such as transport, domestic energy consumption, industry, domestic wastewater, and livestock rearing.

Based on a comprehensive data analysis, the action plan envisions an emission reduction pathway under two scenarios: BAU (Business as Usual) and CN50 (Carbon Neutral 50). According to this, in the Business-As-Usual (BAU) scenario, total greenhouse gas emissions are expected to rise to the equivalent of 31.9 million tonnes of CO<sub>2</sub> by 2050. In 2021, this was equivalent to 22.0 million tonnes of CO<sub>2</sub>.



(Graphs: Emissions reduction trajectory in million tonnes CO<sub>2</sub> eq in Kerala, in BAU and CN50 scenario)

This increase is mainly driven by the energy sector, particularly the transport sector. On the contrary, in the Carbon Neutral (CN50) scenario, total emissions are expected to decrease to the equivalent of 8.3 million tonnes of CO<sub>2</sub> by 2050. This indicates that carbon neutrality will be achieved well before 2050. Various sectoral interventions in energy, waste, agriculture, land use, land-use change, and forestry (LULUCF) sectors are the primary reasons for this significant reduction in emissions.

Some of the major interventions targeted in the action plan to reduce emissions from key emission sectors mentioned in the plan such as transport, domestic energy use, industry, domestic wastewater, and livestock rearing are listed below:

- Enable emission reduction by electrifying transport, industry, and cooking sectors in the State.

- Develop renewable energy capacity through solar energy, wind, and energy storage systems to meet the increasing energy demands of the State.
- Increase carbon sequestration through forest rejuvenation, agricultural afforestation, and Blue Carbon (mangroves, wetlands).
- Utilize Green Hydrogen energy for heavy-duty transport and industrial applications.
- Implement energy generation from organic waste (Waste to Energy).
- The implementation of projects as mentioned above will significantly reduce Kerala's net emissions and help achieve the goal of carbon neutrality by 2050. Steps to finalize the draft action plan are currently being taken by the Directorate.

## **2. Kerala State Pollution Control Board (KSPCB)**

### **Key Recommendations**

- Mandatorily segregate waste at the source based on primary characteristics.
- Ensure scientific treatment of organic waste at the source (households and institutions) as much as possible.
- Ensure decentralized community facilities for organic waste arriving from sources.
- Ensure doorstep collection and scientific treatment of non-organic waste through authorized agencies like Haritha Karma Sena.

## **3. Kerala Water Authority (KWA)**

### **Quality Control Wing**

The Quality Control Wing of the KWA conducts inspection and monitoring of drinking water distributed through various water supply schemes. Along with this, under the *Jal Jeevan Mission*, it also monitors the water quality of other water sources such as open wells and borewells in rural areas.

The Quality Control Wing of KWA includes the following:

- State Referral Institute (SRI)
- District Labs – 14 (One in each district)
- Sub-District Labs – 71

With the staffing arrangements in the 14 district laboratories, the responsibility of monitoring the water quality of all water supply schemes of KWA is carried out. There is a three-tier system and a set protocol to analyse water samples at fixed frequencies at the AE/AEE/EE levels. For this purpose, the projects have been divided into 5 categories. The classification of the projects and the frequency of monitoring are included in the table below.

## Project Classification and Frequency of Monitoring

| Category of K.W.A. Schemes | Beneficiary Population              | Inspection / Monitoring Conducted By |                   |                               |
|----------------------------|-------------------------------------|--------------------------------------|-------------------|-------------------------------|
|                            |                                     | AE                                   | AEE               | EE                            |
| <b>Category A</b>          | Population above 1 Lakh             | Monthly                              | Once in 2 months  | Once in 3 months              |
| <b>Category B</b>          | Population from 50,000 up to 1 Lakh | Once in 2 months                     | Once in 4 months  | Once in 6 months              |
| <b>Category C</b>          | Population from 20,000 up to 49,000 | Once in 3 months                     | Once in 6 months  | As per requirement / Randomly |
| <b>Category D</b>          | Population from 5,000 up to 19,000  | Once in 6 months                     | Annually          | As per requirement / Randomly |
| <b>Category E</b>          | Population less than 5,000          | Annually                             | When issues arise | As per requirement / Randomly |

Currently, district laboratories test drinking water for a minimum of 17 physical and chemical parameters and two bacteriological parameters. The details of the tested parameters are shown below.

| Water Quality Parameters Tested in District Laboratories |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Physico-Chemical Parameters</b>                       | <ol style="list-style-type: none"> <li>1. Colour</li> <li>2. Odor</li> <li>3. Turbidity</li> <li>4. pH</li> <li>5. Electrical Conductivity</li> <li>6. Acidity</li> <li>7. Alkalinity</li> <li>8. Sulphate</li> <li>9. Total Dissolved Solids (TDS)</li> <li>10. Total Hardness</li> <li>11. Calcium</li> <li>12. Magnesium</li> <li>13. Chloride</li> <li>14. Fluoride</li> <li>15. Iron</li> <li>16. Nitrate</li> <li>17. Residual Chlorine</li> </ol> |

|                                   |                                   |
|-----------------------------------|-----------------------------------|
| <b>Bacteriological Parameters</b> | 18. Total Coliform<br>19. E. Coli |
|-----------------------------------|-----------------------------------|

Each district laboratory analyses approximately 100 KWA (Kerala Water Authority) project samples and an average of 200 private samples per month (this can go up to 700 in certain labs). The analytical results of water samples from KWA schemes are forwarded to the officers responsible for the operation and maintenance wing of the projects to take corrective actions. In addition, the quality of chemicals such as alum, lime, and bleaching powder used for water purification in KWA schemes is also tested in the laboratories to ensure their quality standards.

Jal Jeevan Mission, 14 district laboratories, and 71 sub-district laboratories conduct quality analysis and sanitary inspection of drinking water sources, including open wells and borewells, as well as FHTCs (Functional Household Tap Connections) in rural areas. Among these, 14 district laboratories and 69 sub-district laboratories have obtained NABL accreditation during the 2022-24 period. Currently, sub-district laboratories are working towards achieving NABL accreditation, while district laboratories are maintaining their NABL accreditation. Lab activities are underway for district laboratories and SRI (State Referral Institute) to obtain NABL accreditation for microbiology parameters. Each sub-district laboratory tests 250 rural drinking water sources, FHTCs, and private samples every month. The results of the water sample analyses are uploaded to the Government of India's WQMIS (Water Quality Management Information System) website. District laboratories test 250 roster samples in addition to project samples and private samples. There is a permanent Sanitary Chemist from KWA in each district laboratory, who is also responsible for the functioning of the sub-district laboratories in that district. Other chemists are appointed on a contract basis for the functioning of district and sub-district laboratories. For microbiology laboratories, except in SRI, there is a permanent microbiologist post in each lab, and they are currently working on a contract basis.

The State Referral Institute (SRI), which is the apex institution in the State, functions at Nettayam. In addition to the common parameters mentioned above, it has facilities to test metals and pesticides. The analysis of metals, including toxic elements, is carried out using Atomic Absorption Spectroscopy (AAS). Pesticides are analyzed using Gas Chromatography. Raw water samples from the intake points of the projects are tested for heavy metals and pesticides during pre-monsoon and post-monsoon periods. Further, 5% of the roster samples from the district laboratories are also tested here. The heavy metals and pesticides tested at SRI are listed below.

| <b>Heavy Metals and Pesticides Tested at SRI</b> |                   |                     |
|--------------------------------------------------|-------------------|---------------------|
| <b>Toxic Substances</b>                          |                   | <b>Other Metals</b> |
| <b>Pesticides</b>                                | <b>Metals</b>     |                     |
| 1. Aldrin/Dieldrin                               | 1. Lead           | 1. Manganese        |
| 2. Alpha HCH                                     | 2. Total Chromium | 2. Copper           |
| 3. Beta HCH                                      | 3. Nickel         | 3. Aluminium        |
| 4. Delta HCH                                     | 4. Aluminium      | 4. Zinc             |
| 5. DDT                                           | 5. Molybdenum     | 5. Iron             |
| 6. Endosulfan                                    | 6. Cadmium        | 6. Silver           |
| 7. Gamma HCH                                     |                   | 7. Selenium         |

The State Referral Institute received NABL accreditation in March 2017. Currently, it has NABL-accredited test facilities for 48 parameters. This includes 11 metals, dissolved oxygen, BOD, TSS, PO<sub>4</sub>, silica, ammonia N, nitrate, etc., and 17 common parameters.

#### **4. Kerala State Biodiversity Board**

National Biodiversity Authority (NBA)

The Convention on Biological Diversity (CBD), one of the most important international agreements related to biodiversity, signed by 196 countries including India, came into force on December 22, 1993. The Indian Parliament passed the Biological Diversity Act, 2002, to effectively implement the objectives of the CBD. Subsequently, the Biological Diversity Rules came into force in 2004.

The Act was established with the objectives of conservation of biological diversity, sustainable use of biological resources, and ensuring the equitable sharing of benefits arising out of the use of traditional knowledge associated with them. To implement the Biological Diversity Act, the National Biodiversity Authority (NBA) was established in 2003 with its headquarters in Chennai. The NBA, which is a legally autonomous body, functions to enforce the provisions of the Biological Diversity Act, ensure smooth execution of duties, and act as an advisory committee to the Central and State Governments on related matters.

#### **Main Objectives of the Biological Diversity Act**

According to the provisions of the Convention on Biological Diversity, which states that a country has sovereign rights over the biological resources falling within its jurisdiction, the Act exists for the conservation of our country's biodiversity. Following this, most states framed their own Biodiversity Rules as part of implementing the Biological Diversity Act. The Kerala State Biological Diversity Rules came into force in 2008. The core components of the Biological Diversity Act are the conservation of biodiversity, the sustainable use of biological

resources, the utilization of biological wealth, and the fair and equitable sharing of benefits arising out of such utilization (Access and Benefit Sharing).

It is estimated that after 1900, there has been a 75% decline in the diversity of crop varieties in agricultural fields. In the case of livestock, this decline stands at 30%. There are about 50,000 plants in the world that are edible in some form or another. However, 75% of the food required by mankind comes from just 12 plants (rice, wheat, maize, potato, cassava, soybean, tomato, banana, onion, apple, grape, and sugarcane) and 5 animals (cattle, goat, sheep, pig, and poultry). Another remarkable fact is that among these, just three crops (rice, wheat, and maize) alone provide 60% of the required food. When it comes to Kerala, the situation changes slightly. We have to consider three food crops: rice, cassava, and wheat. However, there is no native production for these. We face a pathetic situation where we have to depend on other states for the majority of our dietary needs.

The diversity followed by Keralites in their diet is amazing. Sambhar, Erissery, and Avial, which contain plenty of vegetables, are examples of this. However, we must not forget the fact that the dietary habits of the new generation are reducing food diversity and leading to lifestyle diseases.

The method generally adopted by countries across the world for the conservation of agricultural biodiversity consists of ex-situ (outside the habitat) conservation methods. Seeds can be preserved for a long time at very low temperatures. Seed preservation centres across the world store more than 7.4 million varieties of seeds in this manner. Technical support for this is provided by an institution in Rome called 'Biodiversity International'. In India, an institution under the Government of India called the 'National Bureau of Plant Genetic Resources' preserves more than 4.5 lakh seed varieties.

In addition to this, most government-owned crop-centric research centres maintain field gene banks or germplasm collections.

Recently, nations around the world have started efforts to identify and encourage a category of farmers called Custodian Farmers who protect and preserve agricultural biodiversity. The Biodiversity Board in Kerala has a specific project for this. What they practice is on-farm conservation of diversity within agricultural fields. Identifying and encouraging such custodian farmers is the responsibility of BMCs (Biodiversity Management Committees) for several reasons that motivate them to engage in such conservation activities.

### **Need for Biodiversity Conservation**

According to estimates by the Food and Agriculture Organization (FAO), which is part of the United Nations, 40% of the world's economy is directly or indirectly based on the use of biological resources. The strongest guarantee for the conservation of biological resources is their sustainable use. Lessons learned from sustainable use can be applied to all economic activities, including agriculture, livestock management, forestry, fisheries, and bio-fuel production. Following the general guidelines of sustainable management provides healthy ecosystems, economic benefits, and other advantages to the people. The utilization of biodiversity is a powerful tool to achieve sustainable development, as underscored in the action

plan adopted by the World Summit on Sustainable Development, and consequently to alleviate poverty. Although our biodiversity is rich with native ecosystems and native species, it is currently facing severe depletion due to natural environmental issues like soil erosion, landslides, debris flows, and floods, as well as numerous human-induced environmental problems. These include the reclamation of fields, filling up of wetlands, uncontrolled sand mining from rivers, saltwater intrusion into rivers during high tide, unregulated and unscientific rock quarrying, laterite stone mining, coastal sand mining, destruction of mangrove forests, destruction of sacred groves (*kavukal*), and encroachment on backwater-river banks. Unscientific farming practices, pollution, excessive use of chemical fertilizers and pesticides, unscientific construction activities, and the invasion of alien species also contribute to this depletion.

The survival of other living beings is essential for the survival of the human race. Therefore, it is our responsibility to fully understand and protect our biodiversity. We possess, knowingly or unknowingly, a wealth of traditional knowledge and practices associated with biodiversity. Consolidating all of these is a necessity of our time. If we fail to do so, people from other nations will exploit them, and we will lose our rights over them. Therefore, records of biological resources and associated traditional knowledge must be documented at the Grama Panchayat, Block Panchayat, District Panchayat, Municipality, and Corporation levels. Along with protecting them, such knowledge must also be updated periodically.

Our invaluable biological wealth forms the baseline for our food, housing, medicine, and more. As far as we are concerned, rice holds the primary place among the plants used for food. More than 300 varieties of paddy are cultivated in Kerala. Rice varieties with medicinal properties include Navara, Chennellu, Karutta Chembavu, and Variyanellu. Tuber crops are a major component of the diet of Keralites. Prominent among the fruits are banana, mango, jackfruit, gooseberry, and Malabar tamarind (*kudampuli*). There are also fruits like fig (*atthi*), cluster fig (*itthi*), *moottilppazham*, *vetti*, and *anjili*. Our forests are a biological storehouse of such plants. A large number of exotic fruits such as cashew, sapota, mangosteen, rambutan, *moottippazham*, custard apple, guava, rose apple, *chathurappuli*, water apple (*chamba*), papaya, passion fruit, pineapple, bilimbi, dragon fruit, durian, pomelo (*kambili naranga*), miracle fruit, and star apple are also grown in Kerala. Among the plants yielding essential oils, the important ones are sandalwood, chempakam, ramacham, and lemongrass. Certain plant parts are used to produce vegetable dyes. Prominent among these are *aavaram* flower, mustard, *thannikka*, and *thovalyappattu*. A vast number of plants, minerals, and animal parts are used in Indian systems of medicine like Ayurveda and Siddha. Even today, tribal communities primarily rely on biodiversity-based resources for curing diseases. Apart from Indian medical systems, chemical components extracted from plants are also used as medicine in Allopathy, the modern medical system.

Wildlife and the products derived from them generate substantial economic gains. Fish and meat hold a prominent place in our diet. The excessive use of pesticides and the reclamation of wetlands lead to the destruction of fish found in these ecosystems. Promoting tourism by providing opportunities to view animals in their natural habitats is a good source of income (Eco-tourism). Animals are used in medical science to observe the efficacy of medicines. In

addition to this, we utilize the animal kingdom to fulfil various needs such as food, clothing, recreation, and health.

Mangrove forests are complex ecosystems consisting of trees and shrubs that grow in estuaries, marshes, and lagoons. Mangrove trees and other associated mangrove plants grow in these areas. They grow in brackish water where rivers and seas meet. They are also called mangrove shrubs. Mangrove forests grow in the wetlands of tidal areas that are submerged in water during high tide and exposed to the atmosphere during low tide. In Kerala, mangroves are most extensively found in the Kannur district. Mangrove forests are among the most biodiverse ecosystems on Earth. These mangrove forests have several times more capacity to absorb carbon from the atmosphere than tropical forests. Thus, they help reduce atmospheric pollution to a certain extent. Along with this, they release large amounts of oxygen. These areas are ideal for various species of aquatic life, including fish, to breed safely, and for birds to build nests. Not only that, they have an amazing capacity to resist natural disasters. Their conservation is definitely a major part of environmental protection.

It is the responsibility of local self-government institutions to periodically update the People's Biodiversity Register prepared at the local level and convert it into a digital format. It should be viewed as a serious responsibility of the BMCs (Biodiversity Management Committees) to prepare and implement a blueprint on what activities should be conducted for the promotion of biodiversity in the coming years. Through multi-level planning, local self-government institutions must join hands with various departments to achieve this goal.

**The duties of the State Biodiversity Boards are as follows:**

- Conservation of biodiversity.
- Sustainable use of biological resources.
- Equitable and fair sharing of benefits arising out of products derived from biological resources and knowledge associated with them.
- Advise the State Government in accordance with the guidelines issued by the Central Government on matters related to these.
- Regulate and grant approvals for applications made by Indians for commercial utilization of any biological resource, determination of its scope, or other types of needs.
- Perform duties necessary to make the provisions of this Act practical, or as directed by the State Government.
- Intervene in matters regarding any activity that is detrimental to biodiversity depletion.
- Constitute and operationalize Biodiversity Management Committees in local self-government institutions.

## **Biodiversity Management Committee (BMC)**

Biodiversity conservation activities at the local level must be carried out through Biodiversity Management Committees. It is the responsibility of the BMC to conserve biological resources, ensure their sustainable use, manage ecosystems, and preserve traditional varieties, native breeds, landraces, wild varieties, and microbes, as well as to document information related to them. That means plants, animals, microbes, agricultural crops, and fauna naturally found in the locality, as well as flora and fauna used for traditional medicine and other purposes, must be documented. To collect associated knowledge periodically, all local self-government institutions must constitute Biodiversity Management Committees (BMCs) within their jurisdiction, in accordance with Section 41 of the Biological Diversity Act and Section 20 of the Kerala State Biological Diversity Rules, 2008. The National Biodiversity Authority, the State Biodiversity Board, and the local BMC must be consulted for any decision regarding local biological resources and biodiversity-related knowledge. Looked at this way, BMCs hold a vital position at the local level. The State Biodiversity Board at the state level and the BMCs at the local level are statutory bodies (possessing the legal authority to enforce procedures).

### **Structure of the BMC**

The BMC is an eight-member committee formed as per Section 41(1) of the Biological Diversity Act, 2002, Rule (22) of the Biological Diversity Rules, 2004, and Section (20) of the State Biological Diversity Rules, 2008. Apart from the Chairperson and Secretary, who are designated by the governing body of the local self-government institutions, there shall be six other members in this committee. Among the nominated members, one-third must be women, and at least one person must belong to the Scheduled Caste/Scheduled Tribe category. The selected individuals should belong to categories such as local traditional healers (*naattuvaidiyar*), farmers, collectors/sellers of timber and non-timber forest products, fisheries workers, members of organizations utilizing biodiversity, social workers, teachers, researchers, or individuals from voluntary organizations who are trusted to actively contribute to BMC activities. Special care must be taken to ensure that the nominated individuals reside within the jurisdiction of the local self-government institution and are registered voters in the electoral roll.

### **Duties and Responsibilities of the BMC:**

- A major responsibility of the BMC is to prepare the People's Biodiversity Register (PBR). It is the duty of the BMC to update it periodically with the cooperation of the public and the technical advice of the KSBB (Kerala State Biodiversity Board), ensure it remains fit for use, protect the information within the biodiversity register, and provide it to needy parties in accordance with the law.
- Ensure the conservation of biodiversity and the sustainable use of biological resources.
- The renovation of local biodiversity.
- Inform the State Biodiversity Board and the NBA (National Biodiversity Authority) of precise details regarding Intellectual Property Rights (IPR), traditional knowledge, and local issues related to biodiversity.

- Manage Biodiversity Heritage Sites (BHS) (e.g., sacred groves, water bodies, etc.).
- As per the directives of the KSBB (Kerala State Biodiversity Board), BMCs shall levy collection charges/fees for accessing or utilizing biological resources falling within their territorial jurisdiction for commercial purposes, as well as for regulation and knowledge dissemination control.
- Conservation of traditional varieties of plants and animals that hold economic importance.
- Biodiversity studies and awareness generation.
- Protection of traditional knowledge documented in the People's Biodiversity Register (PBR).
- Ensure that biodiversity is being conserved and that the revenue generated from it is shared equitably and fairly.
- Take the lead in preparing and implementing Biodiversity Management Plans by using the knowledge in the People's Biodiversity Registers and with the assistance of the Board.
- Manage the Local Biodiversity Fund in accordance with the Biodiversity Act and Rules.
- Prepare annual reports and accounts and submit them to the KSBB.
- Hand over details regarding biodiversity as and when requested by the KSBB or other authorized institutions for the requirements of local healers and traditional medical practitioners.

#### **BMCs – 'Local Environmental Watchdog Group'/ Protection squad**

- BMCs should function as the 'Environmental Watchdog Group'/ Protection squad within local self-government institutions. BMCs must act proactively on the following matters:
- Timely inform the concerned authorities about existing or potential environmental issues in their respective localities and take legally permitted actions.
- Implement primary environmental management plan concepts in a participatory manner at the grass-roots level.
- In the event of violations of environmental laws, rules, or notifications, environmental degradation, or situations that pose or may pose a threat to human life and health, report the matter to the designated officials responsible for taking legal recourse.
- Take initiative to implement guidelines for environmental management through the Panchayat governing bodies and promptly report to the legal authorities instances where environmental clearance conditions are violated (e.g., stone quarries, sand mining, development projects with prior environmental clearance).

- Lead awareness programs to ensure a healthy environment, environmental protection, and sanitation.
- Ensure the natural protection of water sources and take the initiative in public projects viable for the rejuvenation and sustainable conservation of degraded water bodies.
- Lead environmental protection/cleaning activities at the local level.
- Organize discussions, seminars, and awareness programs on local environmental issues by collaborating with educational institutions, cultural centers, environmental organizations, and environmental activists operating locally.
- Directly understand and report to the concerned parties regarding the environmental status of the area, unauthorized exploitation of natural resources, current status of ecosystems, etc.
- Present primary environmental protection measures in the Grama Sabhas/Ward Sabhas and work towards integrating them into the projects of the local self-government institution.
- Prepare the Local Action Plan for Biodiversity Management Plan (LAPBMP) in a participatory manner.
- Implement government projects related to environmental conservation (e.g., good agricultural practices, organic farming, conservation of native flora and fauna, biogas production, rainwater harvesting, protection of water sources, tree plantation, solar energy, etc.).

The technical support required for BMCs to function effectively as an 'Environmental Watchdog Group' will be available through the 'Technical Support Groups' formed by the State Biodiversity Board at the district level.

### **Biodiversity Conservation**

- Take the lead in taking necessary steps to identify biodiverse areas that fall under the jurisdiction of more than one BMC, as per the Biodiversity Act and rules, and declare them as Biodiversity Heritage Sites (BHS) through the government.
- For example, if the area falls within the jurisdiction of different Grama Panchayats in the same Block, steps can be taken under the supervision of the respective Block Panchayat BMC. If the areas fall within the jurisdiction of more than one Block, or similarly, under the common jurisdiction of Panchayats, Municipalities/Corporations, steps can be taken under the supervision of the District Panchayat BMC, with the knowledge of the Block Panchayat.
- Declaration of Local Biodiversity Heritage Sites: Ecosystems/trees of local biodiversity importance and bio-richness can be directly declared and protected by the BMC as local biodiversity heritage sites/trees. The Block and District BMCs can take leadership for this purpose.

- Biodiversity Conservation Projects: All BMCs must include a fixed amount in their annual plan fund for the conservation of biodiversity and sustainable use of bio-resources in the area under their jurisdiction. This can be included as a proposal of the working group for biodiversity conservation, namely the Biodiversity Management Working Group. The representation of BMC members in the Biodiversity Working Group must be mandatory.
- District-level / Block-level BMCs should coordinate activities to ensure the time-bound completion of biodiversity conservation projects.
- Priority should be given to planning eco-habitat conservation projects based on the PBR
- Implement projects related to the environment and biodiversity under the supervision of District/Block level BMCs, in collaboration with various departments such as Agriculture, Forest, Environment, Animal Husbandry, Fisheries, and various government missions.
- All kinds of environmental and biodiversity conservation projects shall be implemented only under the supervision of the BMC. The funds for the said projects should be deposited into a special account for the BMC (Local Biodiversity Fund). The Local Biodiversity Fund account should be opened as a joint account in the name of the BMC Chairperson and Secretary.
- Intervene in issues related to environmental and biodiversity conservation.
- Act as environmental vigilance groups to avoid environmental degradation locally. Give timely instructions to the concerned departments to take action.
- Coordinate the activities of the respective BMCs at the Block and District levels regarding issues related to the conservation of eco-habitats involving more than one Grama Panchayat/Municipality/Corporation.
- The District Panchayat BMCs should undertake precise monitoring and preparation of action plans for BMC activities at the Grama Panchayat/Municipality/Corporation levels; the Block Panchayat BMCs should monitor and prepare action plans for Panchayat BMCs; and the District Panchayat BMCs should monitor and prepare action plans for Block Panchayat BMCs and Municipality/Corporation BMCs.
- BMC Meetings: All BMCs must meet separately at least once every three months, and the minutes must be made available to the Board.
- Ensure the participation of BMC members in the working groups on 'Biodiversity Management, Climate Change, Environment Protection, and Disaster Management' formed in Local Self-Government Institutions (LSGIs), coordinate the activities of the working groups under the supervision of the BMC, and formulate projects for the conservation of environment-eco-habitats.

### District-level Details of PBRs

| Sl. No. | District           | Total Number of PBRs Prepared                                           |
|---------|--------------------|-------------------------------------------------------------------------|
| 1.      | Thiruvananthapuram | 73 Grama Panchayats + 4 Municipalities + 1 Corporation                  |
| 2.      | Kollam             | 68 Grama Panchayats + 4 Municipalities + 1 Corporation                  |
| 3.      | Pathanamthitta     | 53 Grama Panchayats + 4 Municipalities                                  |
| 4.      | Alappuzha          | 72 Grama Panchayats + 6 Municipalities                                  |
| 5.      | Kottayam           | 71 Grama Panchayats + 6 Municipalities                                  |
| 6.      | Idukki             | 52 Grama Panchayats + 2 Municipalities                                  |
| 7.      | Ernakulam          | 82 Grama Panchayats + 13 Municipalities + 1 Corporation                 |
| 8.      | Thrissur           | 86 Grama Panchayats + 7 Municipalities + 1 Corporation                  |
| 9.      | Palakkad           | 88 Grama Panchayats + 7 Municipalities                                  |
| 10.     | Malappuram         | 94 Grama Panchayats + 12 Municipalities                                 |
| 11.     | Kozhikode          | 70 Grama Panchayats + 7 Municipalities + 1 Corporation                  |
| 12.     | Wayanad            | 23 Grama Panchayats + 3 Municipalities                                  |
| 13.     | Kannur             | 71 Grama Panchayats + 9 Municipalities + 1 Corporation                  |
| 14.     | Kasaragod          | 38 Grama Panchayats + 3 Municipalities                                  |
|         | <b>Total</b>       | <b>1034 (941 Grama Panchayats + 87 Municipalities + 6 Corporations)</b> |

### Biodiversity Knowledge Centre

The Biodiversity Knowledge Centre (BDKC) can be started under the control of Local Self-Government Institutions in association with public libraries, under the supervision of the BMC. Responsibilities including raising awareness regarding biodiversity conservation can be carried out under the charge of this centre. Necessary books can be obtained from the Board for free or otherwise and can be utilized by libraries or Local Self-Government Institutions. This can be utilized in a manner that is highly beneficial to students, researchers, and job aspirants.

### Kerala State Biodiversity Congress

The first Kerala State Biodiversity Congress, under the auspices of the Kerala State Biodiversity Board, was held from January 26 to 28, 2019, at Government Brennen College, Thalassery. 'Climate Change and Biodiversity Rejuvenation' was the main theme. In the wake of recent natural disasters faced by Kerala, the Biodiversity Congress primarily put forward the idea of restoring our environment and bio-habitats and ensuring sustainable development of a new Kerala by planning and implementing action plans to protect indigenous bio-species. The first Biodiversity Congress was inaugurated by the Chief Minister of Kerala, Shri Pinarayi Vijayan. Presentation of scientific papers on biodiversity topics, and the exhibition and sale of various seed varieties by traditional farmers were also held as part of the program.

## **Children's Biodiversity Congress (CBC)**

Uncontrolled exploitation of resources and human encroachment, along with unscientific development models, are severely affecting the rich biodiversity of Kerala. Environmental conservation, along with awareness activities, will help children become guardians of environmental protection. Quiz, painting, and photography competitions involving upper primary and high school students of Kerala, as well as project presentations by children aiming at biodiversity conservation, are organized at the district and state levels. The Children's Biodiversity Congress, which is held every year, had its inception in the year 2008.

## **Biodiversity Club**

Biodiversity clubs aim to provide an opportunity for children to study and understand the environment and ecosystems around them, conduct studies to find solutions to environmental problems, and closely reclaim nature, which is currently on the path of destruction. Indigenous communities, such as tribal people living in harmony with nature, are capable of sharing traditional knowledge about nature that has been acquired over generations through word of mouth in local languages. They can recite the names of nearly hundreds of medicinal plants, birds, and fish in a single breath, along with associated insights. As generations pass, such valuable traditional knowledge is fading and gradually getting buried. In this scenario, we must realize the relevance of documenting such knowledge. However, due to changing circumstances, the opportunity to live by knowing nature is decreasing. Therefore, it is imperative to make efforts through Biodiversity Clubs to conduct local-level research studies aimed at the sustainable development of students' environments, understand biodiversity regions, and ensure sustainable utilization.

### **Aims and Objectives:**

- Create awareness about biodiversity and its sustainable use.
- Conduct studies in schools and colleges regarding the local biodiversity of their surroundings.
- Identify the key components that enhance the biodiversity of the local environment and ecosystem.
- Promote progress in biodiversity conservation within schools and colleges.
- Impart knowledge about the benefits of ecosystems rich in diverse living organisms to students, families, and society.

## **Rebuild Kerala Initiative**

### **1. Agricultural Biodiversity Conservation**

Home gardens in Kerala are considered one of the primary storehouses of tropical biodiversity. These are comparable to tropical forest ecosystems. Furthermore, the home garden is a highly productive habitat. Each home garden is a site for the conservation of food crops, medicinal plants, trees, aromatic spices, fodder, and flowering plants. Plant varieties developed naturally over generations by farmers (landraces) and several wild varieties can be seen here. The efforts of farmers over years lie behind identifying such high-quality plants. Landraces possess greater genetic diversity than new seed varieties. This includes plant species that are uniquely suited to the local climate and capable of surviving climate change.

The Kerala State Biodiversity Board conducted a rapid assessment study on the impact of floods and landslides on these ecosystems. Through this study, it was found that agricultural biodiversity preserved by farmers suffered severe loss. Recommendations were made on the methods to conserve such ecosystems that were previously protected by farmers. This is a project that prioritizes the eight flood-affected districts of the state.

In every locality, one can find at least a few farmers who preserve traditional varieties (landraces/local varieties) alongside or independent of high-yielding varieties. The primary objective of this project is to identify and encourage such conservationist farmers (Custodian farmers). The project also aims to organize Seed Festivals (Seed fests) to facilitate the exchange of seeds. This project also intends to identify and declare existing agricultural heritage sites in our state as Agrobiodiversity Heritage Sites.

### **2. Revitalization of riparian Biodiversity**

Based on the lessons from the floods and natural disasters of 2018, special strategies have been formulated to implement a project for the rejuvenation of biodiversity on riverbanks. Priority should be given to projects that materialize the "Room for the River" concept (giving space to the river) in a manner that accommodates local specificities, is ecosystem-friendly, suits landforms, and helps mitigate disasters or reduce risk hazards.

Impact studies on the effects of floods/landslides on river greenery were conducted in Pamba, Periyar, Chalakudy, and Bharathapuzha. Studies revealed that the said 4 rivers require urgent attention, and conservation activities need to be carried out across 12% of the riverbank areas. In the second phase, 39% of areas require long-term interventions, while the remaining 17% require only moderate interventions.

To implement such projects for rejuvenating riverbank biodiversity, activities have been initiated as part of the Rebuild Kerala Initiative, involving the Grama Panchayats in the areas where the rivers flow. Along with conserving the natural flora of riverbanks, ecosystem restoration is also included in this. It is hoped that this will serve as a research site for study and can also be converted into tourism zones.

### **3. Commercial Potential of Bio-resources, Valuation-Based Data Collection, and Database Preparation**

Kerala is a state rich in bio-resources with high commercial significance. Economically important plant species and marine flora and fauna are accessible to us. A major challenge Kerala faces in this regard is implementing Access and Benefit Sharing (ABS) as per the Biodiversity Act (2002) - which governs granting access permissions to bio-resources, ensuring their sustainable utilization, and establishing a fair and equitable share of the money/benefits derived from them.

Furthermore, accurate information regarding the uncontrolled collection, unauthorized sale, and smuggling of such bio-resources, their actual current status, the volume being sold, the price obtained, methods of sale, and exploitation is not currently available with us. Therefore, as part of the Rebuild Kerala Initiative, a comprehensive study on commercially traded bio-resources is being conducted across 14 districts. By creating a database of this information, it will be possible to control the unscientific and unauthorized collection and sale of bio-resources. It will also help liberate the tribal communities and fishermen involved in this from exploitation and facilitate the smooth implementation of ABS as per the Biodiversity Act.

#### **People's Biodiversity Register**

India is a land of biodiversity and cultural diversity. Numerous tribal communities whose livelihood depends solely on nature exist here. In addition, there are a large number of farmers, fishermen, and nomadic communities in our country who preserve traditional knowledge. The growth in modern science and technology in general, and the growth in biotechnology and information technology in particular, has immensely increased the importance of biodiversity and its associated traditional knowledge. Today, the importance of biodiversity, bio-resources, and related traditional knowledge is clearly recognized. The first step towards biodiversity conservation and its sustainable use is to document and preserve the biodiversity of each locality. Since biodiversity and related traditional knowledge are spread across various ecosystems, the methods and results of documenting information will also vary.

Guidelines for preparing the PBR taking into account various ecosystems, rural areas, cities, and protected areas:

- This is an activity that must be implemented with the participation of all sections of people within the boundaries of the Local Self-Government Institution.
- When preparing the register, the knowledge and perspectives of both men and women must be documented with equal importance.
- The information obtained from the people must be cross-checked, analysed, and scrutinized with the help of experts from the technical support team.
- Prior knowledge should be recorded in the People's Biodiversity Register only with the knowledge and consent of the individual/community involved.
- This document must be approved by the Biodiversity Management Committee (BMC) and subsequently informed to the Grama Sabha / Grama Panchayat / Panchayat Samiti.

This register will be highly helpful for the sustainable use and management of biodiversity. In addition, it is also a reference book that can be used by universities, colleges, and schools for environmental science studies.

- This document needs to be updated as and when new and additional information becomes available.

**Role of Biodiversity Management Committees in preparing the People's Biodiversity Register:**

The primary duty of the Biodiversity Management Committees is clearly defined in the Biological Diversity Rules of 2004 as follows.

- The primary responsibility of the BMC is to prepare the People's Biodiversity Register in consultation with the local people. This register should contain detailed information about the biological resources of the locality. Information including medicinal values, other benefits, and uses of living organisms must be recorded in the register.
- The other responsibilities of the BMC include keeping information about traditional healers, individuals, etc., who utilize local bio-resources, and providing advice and guidance on matters referred to by the State Biodiversity Board regarding permissions related to the collection and use of biodiversity.
- Detailed information of everyone participating in the collection of biodiversity data must be recorded in the register.

### **Preparation of People's Biodiversity Register**

The first step toward this is to convene the Grama Sabhas and explain its aims and objectives. Identify various groups of people in the village who can assist in data collection. If the biodiversity of an urban area is being documented, areas of biodiversity importance can be identified, and data collection can be carried out. Information can be collected through detailed questionnaires, discussions, and interviews. Secondary references such as books and palm-leaf manuscripts add value to such information.

#### **1. Documenting Traditional Knowledge Related to Biodiversity**

Documenting the traditional knowledge possessed by individuals related to biodiversity is a very crucial part of the process of creating the People's Biodiversity Register. It is sufficient to record only the information that the custodians of local biodiversity knowledge wish to share. For this purpose, a consent form must be obtained from them. Special care should be taken to collect information from elderly people who are capable of providing knowledge about the past and currently non-existent biodiversity. In some contexts, discussions with specific groups of people and consumers will also be required for data collection.

The People's Biodiversity Register is something that must be prepared through energetic and comprehensive consultation with the people, ensuring public participation. Its aims and objectives need to be explained in a meeting involving all sections of people within that Local Self-Government area, members of the governing body, the BMC, children, knowledgeable

individuals, and all others interested in this activity. Photographs, drawings, audio-visual materials, and other printed documents can all be included in the register.

## **2. Ward-level Data Collection Volunteers (DCVs) Groups**

A group consisting of 5 members is selected from each ward, with the Ward Member serving as the Chairperson. The Ward Member and the Convener lead the data collection process in their respective wards.

## **3. Panchayat-level Resource Group (RG)**

The Panchayat-level Resource Group is formed by including residents of the Panchayat such as senior farmers, fishermen, traditional healers (Nattuvaidyars), raw medicinal herb collectors, animal herders, bird breeders, fish farmers, non-timber forest resource collectors, other experts with knowledge and experience in the field of biodiversity, teachers, researchers, workers, social workers, and village leaders. The ward-level data collection should primarily be carried out by visiting the houses of those listed in this group. The BMC (Biodiversity Management Committee) must form this group in consultation with the Panchayat committee members.

## **4. Appointment of PBR Coordinator**

To coordinate the activities conducted under the leadership of the BMC as per the directives of the Board and the Technical Support Group (TSG), and to bear full responsibility for these activities until the People's Biodiversity Register is completely prepared, the Biodiversity Management Committee must appoint a Coordinator, also taking into account the recommendations of the District Coordinator.

## **5. Training Programs**

- A one-day training program for members of the Local Self-Government governing body, BMC, TSG, and RG (approximately 50 people) will be provided by the State Biodiversity Board under the leadership of the District Coordinator.
- A one-day training program will be conducted for the PBR Coordinator and the ward-level data collection volunteers (3 to 5 persons per ward).

## **6. Ward-level Data Collection**

Under the leadership of the Ward Member, the trained ward-level volunteers collect details of the entire biodiversity of their respective wards along with related traditional knowledge and record them in prescribed formats. Information regarding flora and fauna in all types of habitats within the Local Self-Government Institution is recorded in this manner.

## **7. Consolidation of Data**

The data collected from the wards is consolidated at the Panchayat / Municipality / Corporation level into specially prepared formats. To complete this activity, a consolidation workshop is organized with the participation of BMC members, ward-level volunteer group conveners, and TSG members. Subsequently, the consolidation process is completed.

## **8. Preparation of Biodiversity Register**

The data consolidated in the prescribed formats, along with supporting photographs and audio-video CDs, is prepared as the Biodiversity Register of the Local Self-Government Institution and submitted to the governing body for approval. When compiling each study group's data, repetitions must be avoided, and the register should be structured in a format where there is one form per species/variety.

When each study group conducts data collection, it is ideal to carry out the data collection for different sections under the responsibility of different members. When collecting data directly, it does not need to be filled into the form immediately; instead, each study group member should record the complete details systematically in a notebook. As soon as the data collection process is completed, each member must fill the collected details into the forms and hand them over to the group leader. The group leader must ensure that all required information is recorded in these forms. The study group leaders of all wards must hand over these forms to the PBR Coordinator. The responsibility of compiling all the data with the assistance of the Technical Support Group members of the Local Self-Government Institution, avoiding repetitions, and formatting it into forms to create the register rests with the PBR Coordinator. It is the responsibility of the District Coordinator to ensure that the People's Biodiversity Register is fully prepared in a consolidated format in all Local Self-Government Institutions of the district.

## **4. Kerala State Disaster Management Authority (KSDMA)**

### **Temperature Warnings and Precautions**

The Disaster Management Authority issues heatwave alerts for climate-sensitive health hazard warnings and coordinates with the NPCCHH. The authority proposes guidelines through its Heat Action Plan for various departments and institutions to adopt. These include constructing climate-resilient buildings to reduce heat in cities, providing relaxations in working hours during peak sun exposure between 11:00 AM and 3:00 PM, and implementing "Water Bell."

The authority aims to carry out numerous activities beneficial to "One Health," such as promoting climate-resilient healthcare systems by assessing the impact of rising temperatures, vector migration, and air pollution on public health. It advocates for nature-based solutions like restoring mangroves to mitigate the impact of coastal soil erosion and storms. Additionally, it supports afforestation and wetland conservation to prevent biodiversity loss, landslides, and droughts, while promoting sustainable land-use policies to reduce habitat destruction and the rise of infectious diseases.

These disaster mitigation guidelines recommend actions to be taken by Local Self-Government Departments, such as ensuring the availability of drinking water in public places, taking necessary steps to prevent drinking water scarcity, ensuring water quality, arranging water availability for animals, and adjusting working hours. They also cover raising public awareness about health issues caused by heatwaves, hospitals taking precautions to face summer emergencies, identifying health problems due to extreme heat and conducting special monitoring for them, ensuring burn wards in hospitals, and safety measures for food and water

during summer to be taken by the Health and Family Welfare Department. Furthermore, they include providing training to officials regarding heat-related diseases likely to affect domestic animals, birds, and cattle along with their treatments, and operations to deliver preventive medicines to public places and farmers, all of which are to be executed by the Animal Husbandry and Dairy Development Departments.

The guidelines also detail instructions necessary for all departments, such as actions to be taken by the Kerala Water Authority and the Water Resources Department to ensure water quality and rejuvenate water sources, and measures by the Women and Child Development Department to ensure special care, distribution of ORS and IEC materials through Anganwadis, and the availability of required medicines and preparations in health centers for children, pregnant women, unborn children, breastfeeding mothers, women, the sick, and the elderly.

## **5. Suchitwa Mission**

### **Suchitwa Kerala – Waste Management in Rural Areas**

The components under this project are as follows:

- Pre-monsoon cleaning campaign (Health Alert / Arogya Jagratha)
- Establishment and upgrading of solid waste treatment plants
- Source-level waste management
- Liquid waste management including septage treatment plants
- IEC activities, workshops including research and capacity building
- Solid waste collection, transportation facilities, and waste treatment equipment
- Initial-phase support for Self-Help Groups (SHGs) / small-scale entrepreneurs engaged in waste management support services
- Studies on material usage and waste, research, waste management policy formulations, and guidelines
- Mechanization of septage management; social security protection for sanitation workers
- Administrative cost

### **Suchitwa Kerala – Waste Management in Urban Areas**

The State Government attaches great importance to source-level waste management in the waste treatment sector. After identifying appropriate technologies for organic waste management, the unit costs have been fixed. The government provides partial financial assistance to the projects implemented by Grama Panchayats and Municipalities in their respective areas. Local bodies lead pre-monsoon activities during June–July to prevent infectious diseases and other infections. Awareness programs are organized with the help of audio-visual and print media to develop appropriate habits among people for scientific waste management.

Major activities implemented under the Suchitwa Kerala Project:

- Strengthening infrastructure development for source-level treatment of organic waste
- Door-to-door collection and recycling of inorganic waste
- Formation of Haritha Karma Sena
- Construction of MCF (Material Collection Facility) and RRF (Resource Recovery Facility)
- Ensuring advance measures, including marketing, at the local self-government level

### **Swachh Bharat Mission (Gramin)**

This project is designed with the objectives of creating a mass movement by utilizing the capacity of individuals and communities in rural India, maintaining the ODF (Open Defecation Free) status of rural areas, promoting safe and hygienic sanitation habits, and ensuring proper waste management systems in all villages.

The second phase of the Swachh Bharat Mission (Gramin) is being implemented in mission mode for the period from 2020-21 to 2024-25. Considering the entire state of Kerala for this phase, a total expenditure of ₹1500 crores has been proposed. Different from previous phases, this stage is an innovative model aiming at the coordination of various funding channels and multiple schemes of both Central and State Governments. Apart from the budget allocations of the Department of Rural Development and the State Government, the required funds will also be sourced through the 15th Finance Commission funds for Grama Panchayats, Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), and other revenue-generating models.

### **Swachh Bharat Mission (Urban)**

The Swachh Bharat Mission (Urban) originated from the vision to ensure cleanliness, waste management, and sanitation facilities in the country. The main objectives of this project are eliminating open defecation, eradication of manual scavenging (manual cleaning of human excreta), implementing scientific waste management systems, and bringing about behaviour change regarding healthy sanitation practices.

**This project has four main components:**

1. Urban Solid Waste Management Projects
2. Urban Sanitation Projects
3. Urban Information, Education, and Communication (IEC) Projects
4. City Capacity Building Plans

### **Communication and Capacity Development Unit (CCDU)**

The Government of India has approved a dedicated Communication and Capacity Development Unit (CCDU) for the sanitation sector. Its primary objective is to develop

Information, Education, and Communication (IEC), human resource development, and communication strategies suitable for the state, as well as to provide capacity building for workers at all levels.

This unit collaborates with the State Suchitwa Mission and various districts to provide IEC/HRD support. In addition, it provides HRD/IEC services for Swachh Bharat Mission (SBM) projects and state-level projects. The CCDU documents successful state-level IEC/HRD activities and disseminates them among workers at different levels.

### **Haritha Keralam Mission**

Today, approximately 1808 tons of non-biodegradable waste are generated daily in Kerala. Out of this, 400 tons consist of plastic materials. This includes both recyclable and non-recyclable materials. Currently, waste dealers collect thick plastic materials and subject them to maximum recycling. The waste dealer community in Kerala provides a commendable service in this sector. However, they do not collect low-thickness plastic materials. The remaining waste is burned unscientifically or discarded in respective houses, institutions, and public places. This situation must change, and 100% of non-biodegradable waste should be subjected to reuse or recycling.

The Haritha Keralam Mission is a public campaign that focuses its activities on three main areas:

1. **Healthy Waste Management:** Scientific waste management to ensure efficiency in waste disposal.
2. **Water Conservation:** Conservation of soil and water sources.
3. **Agricultural Development:** Preservation and promotion of the agricultural sector, keeping organic farming at the forefront.

### **Objective:**

To clean, sort, and collect all non-biodegradable waste generated in the state from households and institutions, making it available for recycling or reuse. Organic waste should be converted into compost/biogas at the source itself. This scheme is being implemented jointly by the Suchitwa Mission, Clean Kerala Company, Kudumbashree Mission, and the Local Self-Government Department.

### **Kerala Solid Waste Management Project (KSWMP)**

The Kerala Solid Waste Management Project is an initiative implemented with the assistance of the World Bank, allocating approximately Rs.2000 crores to set up state-of-the-art facilities for the scientific management of solid waste in the urban areas of the state. For this purpose, a dedicated project management unit is being formed at the state level, along with sub-project management units at the district and urban local body levels.

## **Sub-projects:**

### **Green Protocol**

In scientific waste management, the global concepts are Reduce, Reuse, and Recycle. The core meaning of this principle is to reduce the amount of waste generated, reuse it to the maximum extent, and then subject it to recycling. The concept of "Green Protocol" was formulated as part of the structural interventions implemented by the Suchitwa Mission to practice its first concept, "Reduce" or minimization.

The principle of the Green Protocol is to avoid the use of all single-use disposable materials and instead encourage the use of eco-friendly products that can be used repeatedly. Its objective is to habituate the complete avoidance of plastic in all daily events and organized programs, using eco-friendly items for serving food and drinks, decoration, and campaigning. Through such activities, the volume of waste generated can be significantly reduced.

Observing the Green Protocol during festivals, celebrations, fairs, and weddings that involve public participation helps reduce the generation of large quantities of waste. The Green Protocol initiatives, which began during the 2015 National Games held in Kerala, are now being observed in all major government events, numerous private functions, festivals, sports and cultural meets, weddings, government offices, and public functions.

### **Swap Shops**

The objective of Swap Shops is to facilitate maximum reuse by allowing individuals to hand over used items instead of discarding them, so they can be utilized by someone else in need (e.g., clothes, bags, toys, electronic goods, etc.). The concept of Swap Shops is a popular idea in Western countries but was largely untried in our region. By adopting this concept, the Suchitwa Mission, in cooperation with Local Self-Government Institutions, has successfully promoted "Reuse." This initiative helps reduce the uncontrolled consumption of valuable natural resources. With the full cooperation of the public, the Local Self-Government Institutions in Kerala organize Swap Shops through the Haritha Karma Sena.

### **Repair Shops**

Repair Shops are facilities established alongside Swap Shops where damaged items from households and institutions can be repaired via the Haritha Karma Sena to make them reusable. These function through the active involvement of the Haritha Karma Sena.

### **Collectors @ School**

This project, implemented by the Suchitwa Mission in schools, aims to create awareness among students about the necessity of sorting and processing waste, and to nurture a generation with sanitation awareness. Under this scheme, units consisting of 4 bins are installed in schools to collect 4 types of non-recyclable plastic waste. The Haritha Karma Sena removes the accumulated waste from these bins every week. As part of the Information, Education, and Communication (IEC) expansion activities of the Suchitwa Mission, funds can be allocated from the sanitation waste management project allocation of Local Self-Government Institutions to set up this scheme under the mini-MCF component.

## **Green Felicitation Centres (GFC)**

Green Felicitation Centres are conceptualized as operational hubs for the Haritha Karma Sena. The project aims to bring all services related to waste management under one roof across every Local Self-Government Institution through the Haritha Karma Sena. Established under government orders, these centers serve as hubs for the public to view and purchase source-level waste management equipment, distribute Green Protocol products, conduct IEC capacity-building activities, and house the Haritha Karma Sena office, among other facilities.

## **6. Kerala State Wetland Authority (SWAK)**

### **Activities of the State Wetland Authority**

- Using the provisions of the Wetlands (Conservation and Management) Rules, 2017, the Directorate of Environment and Climate Change, in collaboration with Wetland International South Asia (WISA) and the Centre for Water Resources Development and Management (CWRDM), has prepared an Integrated Management Action Plan (IMP) for each of the three Ramsar wetlands.
- The Central and State Governments have approved and are implementing the Comprehensive Action Plan to conserve and manage the biodiversity of wetlands and the environmental services they provide. Steps are currently being taken to renew this comprehensive management plan for the next 5 years under the National Plan for Conservation of Aquatic Ecosystems (NPCAA), which is a centrally sponsored scheme.
- Activities are being undertaken to promote sustainable tourism centered around wetlands, skill development, sustainable wetland agricultural practices, marine activities, and maintaining backwater environments. This includes identifying integrated water solutions and monitoring and assessing variations in ecological components and environmental conditions.
- In collaboration with CWRDM, habitat and water quality assessments of Ramsar wetlands are being conducted on a quarterly basis (once every 3 months) to evaluate the health of the wetlands.
- Through the implementation of integrated management plans via various line departments, frameworks for coordination are identified and executed.
- Necessary guidelines and instructions for the conservation and sustainable management of wetlands are provided to the respective execution agencies.
- Steps are being taken to increase awareness among stakeholders and local communities regarding the values and functions of wetlands.
- Providing advice on any other matter referred to it by the State Government administration.

For more information: <https://www.swak.kerala.gov.in>

The three Ramsar wetlands in the state are:



**Vembanad Kol Wetland Complex**



**Ashtamudy Estuary**



**Sasthamkotta Freshwater Lake**

## **One Health – Disease Surveillance, Information Exchange, Disease Control**

### **Directorate of Environment and Climate Change – Information Exchange**

By coordinating all major participating departments and agencies in the state, the Directorate of Environment and Climate Change (DoECC) determines the emission of Carbon Dioxide (CO<sub>2</sub>), Methane (CH<sub>4</sub>), and Nitrous Oxide (N<sub>2</sub>O) from 2005 to 2021 across five critical sectors: Energy, Industrial Processes and Product Use (IPPU), Land Use, Land-Use Change and Forestry (LULUCF), Agriculture, and Waste. The directorate prepares a detailed report on these emissions and has established a web portal incorporating this data. Furthermore, the information is updated on an annual basis. This data is accessible on the Directorate's website (<https://envt.kerala.gov.in>) or via the link <https://climatechange.envt.kerala.gov.in>.

### **KSPCB – Information Exchange**

- Publishing water and air quality monitoring directories/data including state water-air quality monitoring results (<https://kspcb.kerala.gov.in/water-and-air-quality-directory>)
- Making water and air quality monitoring data available on an integrated web portal (Integrated Portal for Pollution Assessment and Monitoring) (<https://ksrec.in/integrated>).
- Two Real-Time Noise Monitoring Stations (RTNMS) in Thiruvananthapuram and Ernakulam districts.
- Annual reports prepared in accordance with waste management rules and reports of studies conducted by the Board are available on the website ([suspicious link removed]).

### **KSPCB AMR Lab**

- The state-of-the-art AMR Lab has been operational in Ernakulam since August 25, 2023. It detects antimicrobial resistance, antibiotic residues, and genomics.
- Equipment used in the laboratory:
  - Liquid Chromatography-Mass Spectrometry (LC-MS/MS)
  - Polymerase Chain Reaction
- Real-time Polymerase Chain Reaction (Quantitative PCR)
- Gel electrophoresis unit
- Gel Documentation System
- ELISA Reader
- Nano drop Spectrophotometer
- Biosafety cabinet

## **Food Safety Department**

Food safety surveillance is a mechanism to collect information on all types of factors that contaminate or adulterate food items. Food safety surveillance must be carried out systematically to identify factors likely to affect food safety in a time-bound manner, to conduct risk assessments, and to provide data required to unify necessary criteria. This must be carried out in a planned manner to provide relevant data for standard setting.

According to Section 29(3) of the Food Safety and Standards Act, 2006, the Food Safety Department must implement food safety/risk communication, food safety surveillance, and related operations at all stages of all food-related businesses based on the urgency and context.

The Food Safety and Standards Authority of India (FSSAI) has prepared a public surveillance plan. States have been directed to implement it in a time-bound and consistent manner.

### **Objectives of Surveillance**

1. Collect, analyse, and summarize scientific and technical information related to the following points and utilize it for planning purposes:
  - a) Food consumption and its associated risk hazards
  - b) Biological hazards and their spread
  - c) Adulteration in food
  - d) Residues of components that contaminate/adulterate food substances
  - e) Identification of potential risk hazards
2. Develop methods for risk assessment, promote guidelines, coordinate efforts, and issue food safety hazard warnings to the government.
3. Implement risk management procedures related to food safety, provide scientific and technical advice and assistance to the government, and prepare a general surveillance plan for food safety management.

### **Surveillance Methods**

- a) Active Surveillance
- b) Passive Surveillance

#### **a) Active Surveillance**

Active surveillance is a mechanism where data regarding the storage, quality standard, and inspection criteria of various ingredients used in food production units are collected jointly by the employees of the production unit, members, or health workers.

The following activities fall under the scope of active surveillance:

1. General Surveillance
2. State Specific Surveillance

3. Seasonal Surveillance
4. Surveillance during festival seasons
5. Surveillance when food-related hazards occur
6. Surveillance related to a specific food item

#### **b) Passive Surveillance**

This is a system for receiving reports from manufacturing units or other sources. This is a low-cost surveillance method that covers large areas.

The objective is to collect data regarding food consumption and biological risks and report them to the government as quickly as possible.

#### **For Effective Surveillance:**

1. Ensuring that food distributed in the market is safe is the objective of food safety surveillance. In the absence of food safety surveillance, consumers will be subjected to various food safety hazards like adulteration, biological risks, and microbes.
2. Several decisions of the Food Safety Authority will be based on such surveillance.
3. Collection of samples and taking legal action as part of enforcement are carried out based on surveillance.

## **Chapter 5**

### **One Health Programme – Duties and Responsibilities of Officials in Various Departments.**

## **Health Department**

### **Duties and Responsibilities of Health Department Officials**

#### **Medical Officer**

##### **➤ Coordination of Various Departments**

- Coordinate the activities of various local self-government level One Health committees.
- Coordinate activities related to epidemic surveillance, control, outbreak/disaster management, etc.
- Utilize the potential of various departments for integrated disease surveillance and control.
- Evaluate activities at specified intervals and prepare and implement action plans for improvement.
- Ensure the cooperation of hospital staff in these activities and evaluate their performance.
- Ensure strict compliance with policies related to infection control programs and waste management in the hospital.
- Implement antibiotic-friendly hospital practices and follow the block-level matrix. Properly conduct activities including prescription audits.
- Coordinate the activities of Health Department staff and One Health volunteers.

##### **➤ Case Reporting**

Ensure preparedness for preventing climate-related diseases (HRI) and other infectious diseases by utilizing information received from field staff as part of disease surveillance and cases reported from the Outpatient (OP) department.

#### **MLSP (Mid-Level Service Provider)**

- Conduct awareness classes on subject-oriented topics - One Health, epidemic surveillance, indicators, etc and utilize the possibilities of e-Sanjeevani. Promptly report danger signs identified in patients visiting the health centre. Follow infection control guidelines.

#### **District Lab Officer**

- Provide guidelines to improve laboratory arrangements.
- Ensure that sample collection is conducted in a manner suitable for preparing an antibiotic antibiogram.
- Hub & Spoke strengthening.
- Share data from private laboratories with the healthcare system.

- Report identified infectious diseases promptly (ensure precision).
- Ensure that guidelines for safe sample collection, preservation, and dispatch for testing are followed.
- Ensure biomedical waste management and personal protective measures.

#### **District Nursing Officer (DNO)**

- Coordinate the activities of nursing staff.
- Oversee infection control, spill management, and needle prick events.
- Ensure that preventive treatment guidelines related to Hepatitis B are displayed and strictly followed.
- Management of rodent control and maintaining records.

#### **Pharmacist**

- Provide awareness on AMR (Antimicrobial Resistance) when dispensing medicines. (Ensure completion of the dose prescribed by the doctor, avoid self-alteration of dosage, etc.)
- Conduct prescription audits and ensure they are promptly sent and reported.

#### **Field Staff**

- Ensure the training of One Health community mentors and volunteers with the cooperation of local self-governments. Implement and strengthen disease surveillance, control, and prevention activities.
- Identify sectors with a high risk of zoonotic diseases and hazardous areas (e.g., poultry farms, hatcheries). Identify environmental conditions requiring surveillance (coastal areas, flood-prone zones, etc.).

#### **Education and Media Sections**

- Prepare specific content in the supplementary sections for designated areas and special occasions targeting specific goals. Support and ensure the cooperation of related departments at the district level.
- Conduct training programs.
- Conduct awareness programs.
- Prepare required content for awareness campaigns as per necessity.
- Utilize newspapers, print media, social media, etc.

#### **Ministerial Staff**

- Allocate and utilize funds for implementing the One Health program.

- Handle correspondence for various departments.
- Ensure accurate auditing.
- Undertake interventions to collect and make funds available in a time-bound manner, including Statement of Expenditure (SOE).

## **Department of Agricultural Development and Farmers' Welfare**

### **Nodal Officer, Project Director, ATMA**

#### **(Agricultural Technology Management Agency)**

#### **Duties and Responsibilities:**

- Coordinate district-level activities related to agriculture; carry out roles and responsibilities of DDA (E&T).
- Conduct awareness programs regarding good agricultural practices.
- Promote safe food habits.
- Implement nutritional food management enterprises.
- Conduct pest surveillance and promote Integrated Pest Management (IPM).
- Organize training programs related to reducing pesticide residues.

#### **DDA-NWDPRA**

- Formulate and implement organic farming projects.
- Implement projects such as GAP (Good Agricultural Practices), BPKP, "Njangalum Krishiyilekka" (We too into Farming), VDP Vegetable Development Programme, and Nutri-rich Mission.

#### **ADA Block Level Monitoring**

- Improve the coordination between blocks and Grama Panchayats.

#### **Agricultural Officers (AO)**

- Function at various levels such as Panchayat, Block, and State.
- Engage in schemes like ATMA, State Horticulture Mission, etc.

#### **General Roles and Responsibilities:**

- Formulate and implement schemes utilizing GAP, INM, and IPM.
- Conduct awareness programs regarding the rational use of pesticides and fertilizers, including good agricultural practices.
- Promote safe food practices among commercial farmers and consumers.
- Ensure that notices regarding crop management, pest and disease infestations, and their control based on MTA are made available to farmers every month.
- Conduct surveillance to control the spread of pests and diseases. Report incidents such as the shedding of organic matter by African snails.

- Utilize the services of pest scouts, ATMA, and block-level BTMs working at the field level and plant health clinics under the Crop Health Management scheme.
- MDDT (Multi-Disciplinary Diagnostic Team) should conduct monthly field visits and implement measures to control disease spread and pest infestations.
- Implement organic waste treatment technologies like vermicomposting to convert waste into manure.
- Promote initiatives such as nutritional gardens, terrace gardens, and "Njangalum Krishiyilekka" (We too into Farming).

### **Animal Husbandry Department**

#### **Duties, Responsibilities, and Roles of Each Category of Staff in Implementing the One Health Programme**

| <b>Field Veterinary Officer</b>                                              | <b>Laboratory Veterinary Officer</b>                                       | <b>District Epidemiologist</b>                                                         | <b>Livestock Inspector</b>                     | <b>Attendant</b>                                                                    | <b>Lab Technician</b>                         |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------|
| Disease examination, sample collection, and overall supervision of the same. | Confirmation, disease diagnosis, and confirmation of disease transmission. | Outbreak investigation, sample collection.                                             | Prior warning/precautionary alert, home visit. | Assists in sample collection.                                                       | Handling samples.                             |
| Provisional disease diagnosis and presumptive diagnosis.                     | Advise farmers and livestock owners on prevention and control program      | Advise farmers and livestock owners on prevention and control programs (IEC programs). | Assists in sample collection.                  | Assists the Veterinary Doctor during epidemics (including conducting post-mortems). | Preparing samples for laboratory examination. |

|                                                                                        |                                                                                                       |                                                   |                                                                                                       |                                         |                                             |
|----------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------|
|                                                                                        | s (IEC programs).                                                                                     |                                                   |                                                                                                       |                                         |                                             |
| Treatment of animals affected by diseases.                                             | Research on zoonotic diseases.                                                                        | Participation in prevention and control programs. | Follow the progress of epidemics and other developments under the supervision of a Veterinary Doctor. | Sanitation/Disinfection.                | Supervision of biomedical waste management. |
| Advise farmers and livestock owners on prevention and control programs (IEC programs). | Data analysis and report preparation.                                                                 | Conduct disease surveillance programs.            | Vaccination.                                                                                          | Setting up the facility (Housekeeping). | Supervision of sanitation/disinfection.     |
| Implementation of Prevention and Control Programmes                                    | Participation in policy decision making discussions for determining prevention and control programmes | Data analysis and report preparation              | Assist the Veterinary Doctor in surveillance programs (Data/Sample collection).                       | Biomedical waste management.            |                                             |
| Participation in disease surveillance programs.                                        |                                                                                                       |                                                   | Stock and storage management.                                                                         | Disbursing samples.                     | .                                           |
| Supervision of                                                                         |                                                                                                       | Supervision of                                    |                                                                                                       |                                         |                                             |

|                      |  |                      |  |  |  |
|----------------------|--|----------------------|--|--|--|
| sanitation/diseases. |  | sanitation/diseases. |  |  |  |
|----------------------|--|----------------------|--|--|--|

**Note:**

1. The District Animal Husbandry Officer shall be responsible for coordination and communication with higher officials, administrative approval, fund sourcing, and ensuring human resource availability.
2. The Chief Veterinary Officer shall provide leadership and coordination for disease control and surveillance activities, ensure their accurate implementation, and coordinate with the three-tier Panchayats.

### **Forest – Wildlife Department**

**Master Watcher:**

- Identification of unusual signs and symptoms: Identify unusual patterns in disease symptoms among animals. Compulsory surveillance and monitoring are required to notice early signs of health issues in wild animals.
- Surveillance of wildlife: Carefully observe differences in the natural behaviour of wildlife, allowing the Forest Department to monitor such animals closely and take appropriate actions.

**Beat Forest Officer:**

- Control: Beat Forest Officers play a decisive role in controlling forest fires that occur periodically in forest areas. Their responsibilities include preventing situations that could lead to fire outbreaks in the first place and taking prompt action as soon as a fire is sighted.
- Survey and Data Collection: Conduct surveys in forest areas, collect data, and implement supportive measures based on the findings to protect the forest range.
- Disease Symptoms: Identify disease symptoms observed in animals within forest ranges. This aids in identifying unusual phenomena and taking subsequent actions.

**Members of Vana Samrakshana Samiti (VSS):**

- Reporting unusual events among wild animals: Report strange incidents observed among wild animals. Report deviations in the health status of animals.
- **Preventive Activities:** Prevent hazardous events that may occur within the forest. For this, cooperate with Forest Department officials.

**Forest Range Officer:**

- Conduct rigorous inspections and carry out steps for disease prevention. Conduct precise inspections and issue warnings regarding animal diseases, as well as execute required measures.

**Rapid Response Team (RRT):**

- Reporting and Response Mechanism: Utilize the existing reporting and response network effectively through the combined efforts of team members, the community, and officials. This helps quickly identify unusual incidents in the forest area and take prompt actions.

## **Irrigation Department**

### **Chief Engineer**

As the head of the state department, the Chief Engineer plans and implements the One Health programme at the state level, assigns officials to coordinate this initiative, and provides procedural guidelines.

### **Superintending Engineer – Zonal Level**

There are 21 Superintending Engineers serving under the state department. They act as officials who provide guidelines at the zonal level regarding the One Health project. Zones are identified by combining the areas of two or three districts.

### **Executive Engineer – District Level**

The district-level head of the department. They review the activities of the One Health programme once a month and report encroachments to the Revenue Department/Collector.

### **Assistant Executive Engineer – Block Level**

Provides guidelines to the officials at the section level regarding the One Health project and reviews their work. Evaluates the operations at the block level once every two weeks and reports encroachments to the Revenue Department/Tahsildar.

### **Assistant Engineer – Panchayat Level**

Identifies field staff, creates awareness among them about the necessity of the One Health programme and waterborne diseases, provides guidelines, and appoints them for data collection across various water bodies. Reviews the activities at the Panchayat level once every week. Reports encroachments to higher officials. Visits sites during emergencies and implements necessary measures.

### **Overseer**

Conducts field inspections once a week in water bodies and canals in connection with the One Health programme. Reviews field inspections and provide guidelines to the field staff.

### **SLR, CLR, Lascar**

Conducts field-level operations as part of the One Health programme. Visits water bodies and canals as part of daily duties as per instructions from higher officials, collects field data, and reports to higher officials. Identifies situations that could lead to unhygienic conditions and analyses encroachments, then relays this data to higher department officials.

## **Drugs Control Department**

### **Drugs Controller**

- Organize and structure responsibilities to fulfil objectives entrusted to the Drugs Control Department regarding One Health.
- Identify the exact expertise and work experience of departmental officials and assign duties in a manner that supports strategic planning goals.
- Evaluate the duties and responsibilities of departmental officials.

### **Deputy Drugs Controller**

- Act as the State Nodal Officer.
- Monitor whether the laws coming under the purview of the Drugs Control Department are being complied with across the state.
- Maintain regular contact with the heads of frontline departments functioning under the Department of Health and Family Welfare.
- Assist the Drugs Controller on policy matters related to One Health.

### **3. State Coordinator**

- Design programs related to One Health.
- Monitor the progress of the One Health programme at the district level.
- Assist the Drugs Controller on policy matters related to One Health.
- Connect and coordinate with the One Health State Team.
- Coordinate programs related to One Health.

### **4. District Coordinators (Most Senior Drugs Inspector in the District)**

- Implement district-level projects related to One Health.
- Implement projects at the district level as well as the block level.
- Function as the coordinator for programs connected with One Health.

### **5. Taluk Coordinator (Drugs Inspectors)**

- Implement projects related to One Health at the taluk level.
- Implement projects at the taluk level as well as the block level.
- Function as the coordinator at the taluk level for programs connected with One Health.

### **6. Structure of District One Health Team**

- District Coordinator
- Public Representative

- Pharmacist
- Retail/Wholesale Drug Trader

## **Fisheries**

### **1. Director**

- Convene a meeting of the State Surveillance Committee immediately upon receiving information regarding disease outbreaks.
- Review investigation reports, assumptions, and remedial actions taken so far, and issue necessary directions.
- If required, conduct a detailed investigation with the assistance of institutions like KUFOS, ICAR, etc.

### **2. Deputy Director/ Assistant Director (District Level)**

- Report diseases detected in the district to the state level.
- Provide leadership at the district level.
- Handle organization and overall supervision.
- Undertake monitoring and evaluation.
- Evaluate contemporary problems/events and identify gaps.
- Coordinate with other concerned departments.
- Team formulation and evaluation.
- Ensure time-bound and accurate reporting.

### **3. Fisheries Extension Officer (FEO)**

- Coordinate the activities of the Fisheries Officer and Assistant Fisheries Extension Officer.
- Provide training for field-level staff.
- Report diseases identified within the Matsya Bhavan jurisdiction to the District Officer.
- Conduct timely visits to places such as hatcheries, farms, aquarium shops, seed farms, etc.
- Monitor and evaluate at the Matsya Bhavan level.
- Ensure time-bound and accurate reporting.
- Participate in infectious disease control and investigations and conduct sample collection.

### **4. Assistant Fisheries Extension Officer (AFEO) / Fisheries Officer (FO)**

- Collect data and information.
- Coordinate information received from promoters and farmers.

- Supervise and review activities at the Panchayat level.
- Give advance warnings/alerts through farm/hatchery visits.
- Participate in disease surveillance programs.
- Collect samples of soil, water, seed, feed, etc., for quality analysis.

#### **5. Aquaculture Coordinator / Promoter**

- Conduct weekly activity evaluations and field visits.
- Coordinate between farmers and Matsya Bhavan.
- Function as a coordinator and advisor at the community level.
- Monitor decontamination/disinfection procedures.
- Monitor farm health cards.

## **Department of Environment and Climate Change**

### **Directorate of Environment – Bhumitra Sena Club**

- Conduct awareness programs regarding diseases transmitting from animals to humans.
- Pollution control awareness: Educate the general public about pollution and how it impacts health. Thereby, reduce environmental factors that can lead to health complications.

### **Kerala State Biodiversity Board (KSBB)**

- Biodiversity conservation.
- Technical Support: The Technical Officer (TO) creates awareness among stakeholders regarding the interaction between biodiversity and health. Ensures that conservation activities support health goals by maintaining ecosystems that contribute to overall public health.

### **Kerala State Pollution Control Board (KSPCB)**

- Control and Compliance: Ensure environmental criteria are met to help reduce the risk of hazards leading to health crises. This environmental awareness and sensitivity is highly indispensable for the health of local communities, especially in areas like riverbanks.

In brief, the following institutions will have a major role in One Health:

- DoECC
- Kerala State Pollution Control Board (KSPCB)
- Kerala State Biodiversity Board (KSBB)
- Kerala State Disaster Management Authority (KSDMA)
- Local Self Governments
- Kerala Water Authority
- Suchitwa Mission
- Voluntary organizations working in connection with environment and climate change

## **Food Safety Department**

### **1. Food Safety Officer**

- Conduct inspections, routine inspections, and risk-based inspections.
- Collect food commodity samples.
- Implement market food safety surveillance and surveys.
- Train food business operators for implementing FSMS plans.
- Create awareness among consumers.
- Assist food business operators in preparing food safety plans.
- Collect data and information regarding outbreaks of foodborne illnesses.
- Visit and inspect regions/areas.
- Collect suspected food samples.
- Dispatch samples to laboratory for analysis.
- Formulate necessary steps for controlling infectious outbreaks in consultation with state food authorities.
- Take follow-up actions.

### **2. Laboratory Officials**

- Chemical / Microbiological analysis of food samples.
- Analyse food samples utilizing the latest technologies.
- Interpret analysis reports regarding food safety and standards (waste materials, toxic substances, residues, regulations 2011).

### **3. Assistant Commissioner of Food Safety (Designated Officer)**

- Design surveillance plans aligned with inspection results and data from other departments.
- Share information with the State Food Authority (Commissioner of Food Safety, Kerala) and other beneficiaries regarding key findings in food safety events.
- Plan IEC activities for consumers, food business operators, and other key stakeholders.

### **Duties and Responsibilities of Medical Officers**

- As per Section 35 of the FSS Act, the Medical Officer must be notified, and the Medical Officer must report details regarding food poisoning/foodborne disease outbreaks within their jurisdiction to the Food Safety District Officer.
- Provide statements regarding occurrences of foodborne illness outbreaks when legal issues arise.

- Instruct local health authorities to collect environmental samples from food establishments as per requirement.

### **Duties and Responsibilities of Health Department**

- Collect data on food consumption history, symptoms, and relevant details of newly reported cases after the preliminary investigation.
- Ensure accurate detection of cases and follow-up actions.
- Distribute clinical reports, stool culture reports, and related information/data to Food Safety Officers.
- Submit reports and perform sanitary inspections of facilities connected with cases where foodborne illness is suspected or confirmed.
- Collect food samples from food establishments based on instructions from the Medical Officer.

### **Epidemiologist**

- Compare the spread of diseases and the distribution of the suspected product to confirm the suspected epidemiological link.
- Lead field-level investigations during outbreaks of foodborne illnesses.
- Cooperate with the Food Safety Department in analysing reports and develop control measures.
- Share required information with the Food Safety Department.

## **Chapter 6**

### **Coordination of Various Departments and Integrated Disease Prevention Activities at State, District, and Local Government Levels.**

In an era of intense global connectivity, infectious diseases can cross borders and reach Kerala rapidly. This highlights the importance of Kerala adopting new approaches to face challenges in the health sector. As part of confronting such challenges, Kerala is implementing the One Health programme with the coordination of various departments.

Cooperation between various departments is one of the key components of primary health care. In a complex healthcare system, such cooperation is indispensable for preventing and controlling diseases. Promoting cooperation among various departments related to common disease prevention across human-animal-environment factors is a specialty of the One Health approach as an allied system for primary health care. Similarly, a true One Health concept can be made practical only through mutual cooperation between various departments.

### **Departments Currently Included in the One Health Programme**

- Department of Health and Family Welfare
- Local Self Government Department
- Animal Husbandry
- Fisheries
- Environment, Climate Change
- Food Safety
- Forest
- Irrigation
- Agricultural Development – Farmers' Welfare
- Drugs Control
- Pollution Control Board
- Kerala Water Authority
- Dairy Development
- Homoeopathy
- Ayurveda

To enable the coordination of the One Health programme, the governance and execution of the programme are carried out by committees comprising representatives from concerned departments at the State, District, and Local Government levels. (Detailed information about the committees at various levels is explained in Chapter 3). State and District level Nodal Officers have already been selected from all concerned departments and training has been provided. They are participants in the planning of the One Health programme.

## **Summary**

This handbook has been prepared to provide training to officials in the Health Department as well as allied departments such as Agriculture, Animal Husbandry, Forest & Wildlife, Irrigation, Drugs Control, Fisheries, Environment & Climate Change, and Food Safety as part of implementing the One Health programme in Kerala. It is expected that this handbook, compiled and prepared using information available from various departments and books, will serve as a reference book for officials.

## Appendix 1

### Prepared By

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